MEMOIRS OF THE GEOLOGICAL SURVEY.

ENGLAND AND WALES.

THE WATER SUPPLY

OF

ESSEX

FROM UNDERGROUND SOURCES.

BY

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AND

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THE RAINFALL, BY H. R. MILL, D.Sc., LL.D.

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PREFACE.

The present volume is an important addition to the series of County Water Supply Memoirs in course of publication by the Geological Survey. In consequence of the wide extent of the county and the many interesting problems connected with its water-resources, this memoir exceeds in size any previous volume of the series. Along with the latest information concerning water-supply, it contains many extracts from old records showing the conditions in past times, and thus furnishes an instructive illustration of the progress that has been made in matters of public health.

The services of Mr. W. Whitaker, formerly of the Geological Survey, and of Dr. J. C. Thresh, for many years the Medical Officer of Health for Essex, were fortunately available for the preparation of this memoir. Mr. Whitaker, during his official connection with the Survey, obtained an intimate knowledge of the geology of the county and, since his retirement, has devoted particular attention to the sources of water. Dr. Thresh, through a prolonged study of the chemistry of the Essex waters, has been able to contribute an account of the subject that is not only more detailed as regards the county than any work of the kind hitherto published, but is of great general interest. He has also freely drawn upon a great store of information relating to all questions of water-supply, which he has gained during his official connection with the County. As in previous memoirs, the rainfall of the county has been dealt with by Dr. H. R. Mill.

Mr. Whitaker has acted as general editor and has been assisted in the preparation of the MS. and in correcting proofs by his son, Mr. H. L. Whitaker.

Besides the specific acknowledgments made in the text, the authors desire collectively to thank the numerous engineers, well-sinkers and other observers for assistance freely rendered in gathering the information now published.

A. Strahan,
Director.

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INTRODUCTORY.

POPULATION.

Although no part of Essex is included in the municipal area of London, yet one can hardly regard its south-western corner as anything but a part of London, and it is dependent chiefly on the metropolitan water supply.

The county of Essex had a population of 1,351,102 at the Census of 1911, showing an increase of 24·6 *per cent.* since that of 1901. These figures include the population of West Ham, then the only county-borough. Since the Census, however, Southend has become one, and this year East Ham will also be one (1915).

Four of what may be called the metropolitan boroughs or districts had a population of over 100,000, two other places of over 50,000, and eight others of over 10,000, to which one more is now added. These are as follows, in the order of the estimated figures for 1913, which have been furnished by the Registrar-General:—

	Census population.	Increase over last.		Present estimate (middle of 1913).
West Ham	289,102	21,744	or 8·1 p.c.	294,223
East Ham	133,504	37,496	or 39·1 p.c.	142,467
Walthamstow, Urban District	124,597	29,466	or 31· p.c.	131,636
Leyton, Urban District ...	124,736	25,824	or 26·1 p.c.	130,922
Ilford, Urban District ...	78,205	36,961	or 89·6 p.c.	87,040
Southend	62,723	33,866	or 117·4 p.c.	70,825
Colchester	43,463	5,090	...	44,669
Barking Town, Urban District	31,302	9,755	or 45·3 p.c.	33,629
Woodford, Urban District ...	18,497	4,699	...	19,622
Chelmsford	18,008	2,436	...	18,592
Romford, Urban District ...	16,972	3,316	...	17,764
Grays Thurrock, Urban District	16,003	2,169	...	16,517
Wanstead, Urban District ...	13,831	4,652	...	14,944
Harwich (including Dovercourt)	13,623	3,553	...	14,473
Clacton, Urban District ...	9,777	2,321	...	10,333

The present estimate for Southend has been increased to 79,789, owing to extension of the borough in November, 1913.

SURFACE-LEVELS.

Whilst Essex contains no really high ground, the highest point being 455 ft. above Ordnance Datum, near Duddenhoe End (? in the parish of Elmdon), but little of the county indeed being above the 400 ft. contour, and that only in the north-western part, yet it has fairly diversified country, with wooded hills and slopes and pleasant valleys.

Nowhere perhaps are the beauties of a clay-tract more in evidence, by far the greater part of Epping Forest, that popular tract so well-known for its sylvan and botanic attractions, being based on London Clay, with the addition only of sundry patches of gravel and sand.

A marked feature of the southern part of the county is made by the broad marshes of the tidal Thames and of its former continua-

tion northward; tracts which are almost wholly beneath the present level of high water.

It should be noted that Essex has suffered in very late years from a lowering of 22 ft. in its highest level, though not from natural causes. A change of county-boundary threw the parishes of Great and Little Chishall and of Heydon into Cambridgeshire, and this took with it a height of 479 ft. at Great Chishall. As a curiosity in names it is notable that the bordering Essex parish, Chrishall, differs only by a letter.

RIVERS.

As regards its rivers Essex is a threefold county: a trinity in unity. The southern part belongs to the *Thames*, and is bordered throughout by the tidal river, except for an incursive fragment of Kent, in this Memoir restored to its proper geographic place (*see* pp. 321, 322).

Into the tidal Thames flow the following streams:—The *Lea* (which generally forms the western border of the county, with its tributaries, notably the *Stort*, which continues the boundary); the *Roding* (at Barking Creek), which is wholly an Essex stream, as also are the still smaller streams to the east; namely, the *Bean* (near Dagenham); the *Ingrebourne* (near Rainham); the *Mar Dyke* at Purfleet; and sundry brooks that are without name on the Ordnance one-inch map.

On the east our county is bordered by the sea, into which flow the following rivers:—The *Crouch*, with the *Roach*; the *Blackwater* or *Pant*, with its various components, the *Can*, the *Chelmer*, the *Wid*, the *Ter*, and the *Brain*; the *Colne*, with its tributaries, the *Roman River*, the *Bourne Brook*, and the *Frating Brook*; the small *Holland Brook*. All these, be it noted, are purely Essex streams, and in addition there is the *Stour*, which forms the north-eastern boundary of the county and has tributaries from Essex, in the shape of the *Belchamp River* and other small streams.

Although the rivers noticed in the last paragraph are now independent, we should not lose sight of the safe inference that they were once tributaries of an extended Thames, from which they have been separated by the cutting back of the land that has been going on for countless years and is still steadily progressing.

Whilst, therefore, Essex may be described as chiefly in the basin of the Thames, or of a once extended Thames, yet on the north-west it is in a different basin, that of the Ouse, its one northerly flowing tributary being the *Cam*, the head-waters of which are in Essex.

The rivers of the county then flow in three general directions, southward, eastward and northward, only some insignificant feeders of the Lea flowing westward. Of course, some streams have an occasional and local westerly course, which, however, does not affect the general direction, and one tributary of the Thames, the Mar Dyke, takes a westerly course at the last, into the easterly flowing tidal river, in defiance of the general rule that a tributary joins a main stream in a direction not reverse to the flow of the latter. It has been suggested that the main stream once flowed along what has since become the Mar Dyke channel.

METHODS OF WATER SUPPLY.

With the exception of the metropolitan part of the county, in the south-western corner, which gets its supply of water from the Metropolitan Water Board, Essex is dependent on wells, with some help from springs.

There are, however, but few cases of widespread supply, the most notable one being that of the South Essex Company, which joins on to the metropolitan supply on the west. The other notable case is that of the Southend Water Company, which, in its turn joins the South Essex district on the west, and the extent of which has been brought about by the impossibility of getting anything like the needful amount for Southend within the border of that place. The company has been forced to make a great number of wells, many at a considerable distance from the town, and of course has to supply the places from which the water is taken. Several other pumping stations have been proposed.

These two companies practically deal with the southern margin of the county, outside the metropolitan supply, and that southern margin is therefore well provided.

The only other large supply is that of Colchester, the whole of which is got in or close to the town; but the Tendring Hundred Company supplies Harwich and a fairly large more or less rural area, and the Herts and Essex Company supplies many places in the north-west.

It must be understood that in the districts of supply of widely extending companies it is often the case that old supplies from shallow wells are still used, and sometimes to a great extent. The substitution of a company's supply is often a slow matter.

So long ago as 1839 Dr. Mitchell wrote as follows[1]:—"There is, perhaps, no part of the world where artesian wells are more general, or are more useful than in Essex. In the vale of the Lea they have been bored with the greatest facility and at a small expense. . . . In the district of Bulpham Fen . . . they yield a large supply of water. In the marshes, as well as along the coast, and in the islands of Essex, they have proved of the greatest utility. Formerly, in some seasons, when the ditches became dry, the cattle suffered, the fishes died, and the farmer lost severely on his stock; but by the aid of artesian wells the ditches are now kept full all the year. . . . In Foulness Island there are no natural springs, and until lately no water, except atmospheric, collected in ditches. In hot seasons this water became putrid, but the inhabitants and the cattle continued to partake of it as long as it lasted; and supplies were then obtained, at the distance of seven miles, from the east end of the island. Artesian wells now keep the ditches full of fresh and sweet water. . . . . Wallisea, Mersea, and other islands have profited in a similar manner." Now it is doubtful whether so good a view of matters can be taken: the increase in the number of wells has in places resulted in the lowering of the water-level.

An old MS. of Sir J. Prestwich (1849) is to the like effect. He says that on almost every farm on these islands (in the marshes) there is a well; that some run faster at high water than at low, and

[1] *Proc. Geol. Soc.*, vol. iii, p. 133.

that they run the same winter and summer, hot or dry. The water which comes from sands sometimes rose 300 ft. in less than three minutes, and he records a number of overflowing wells in the various marshes that form so large a part of the south-eastern corner of the county.

Essex can boast of an old public supply, for DR. LAVER has said that Colchester "had a public water supply in 1424, and it had been almost continuous ever since."[1]

[1] *Essex Naturalist*, 1912, vol. xvi, p. 311.

GEOLOGIC FORMATIONS.

GENERAL ACCOUNT.

The whole county of Essex is in that great geologic district known as the London Basin. This is a long and very irregular shaped flattish trough, narrowing westward; but very broad on the east, in which direction it is continued under the sea. The Chalk forms the rims, usually broad, and the base, whilst the various Tertiary Beds fill the inner part, in successive layers, and the various divisions of the Drift occur irregularly over all.

On the north-west Essex includes part of the northern outcrop of the Chalk, largely hidden by Drift, and it just reaches to the southern outcrop, in the middle of the southern edge of the county.

By far the greater part of Essex, however, is based on the Eocene Tertiaries, and this part is essentially a London Clay tract, modified by coverings of Drift (Boulder Clay and Gravels). This Drift, irregularly disposed, occurs sometimes as great sheets (for the most part one great sheet), but often as separate strips or patches.

Of the formations named in the table some occur only in a few small patches at the surface and have no underground extent: this is the case with the Blown Sand and Shingle, and with the Crag. The Bagshot Beds, too, are present merely as cappings of some of the hills, but extend sometimes beneath Drift. The Alluvium forms the flat bottoms of the stream-valleys and is of fairly broad extent along the Thames, and still more so along the sea-bord of the south-eastern corner of the county.

The Lower London Tertiaries have a long continuous outcrop, except for cappings of Drift, on the north-west and on the south-west, and they continue underground in the tract between, as well as in the eastern part of the county. All the divisions, however, are not so ever-present, but only the middle one, the Woolwich and Reading Beds.

The various gravels and sands of the Drift are of very irregular occurrence, as isolated patches, in many cases very small; as long narrow spreads, either along the lower parts of the valleys or fringing the Boulder Clay of the higher ground; or as a broader sheet, in the valley of the Thames.

The two dominant formations at the surface are the Boulder Clay and the London Clay, which latter reaches its greatest recorded thickness in Essex, namely 530 ft. at Ingatestone (*see* p. 201). The Chalk is the one formation that occurs over the whole county, to a comparatively small extent at the surface, but everywhere else underground. It is, too, the thickest formation of the county, as far as is known, 890 ft. having been recorded at Harwich, on the north-east (*see* p. 184), though on the south-west, at East Ham, the thickness has decreased to 647 ft (*see* p. 144). Besides these two there are only two other borings in the county that go through the Chalk from top to bottom, at Loughton (648½ ft., *see* p. 218) and at Weeley, where a trial-boring has proved 822½ ft. of Chalk (*see* pp. 343, 344).

Of the beds below the Chalk, which do not crop out anywhere in the county, the Upper Greensand has been passed through in two borings on the west, with a thickness of 37 ft. at East Ham (*see*

p. 144) and an indeterminate one, probably about the same, at Loughton (*see* p. 218). It does not occur on the east. The Gault, which presumably occurs underground throughout, has been passed through in four places, besides Saffron Walden (with no good record), and its thickness varies from 61 and 70 ft. on the east, at Harwich and Weeley (*see* pp. 184, 343) to 163 on the west, at East Ham, and probably about the same at Loughton; at which latter place only (save Saffron Walden?) has Lower Greensand been found.

The following list shows the formations which occur at the surface in Essex. The majority of the divisions are of Quaternary and late Tertiary age. Most of the rest belong to the older Tertiaries, only one being of Secondary age. The right column notes the divisions coloured on the Geological Survey Maps:—

	Recent ...	Blown Sand. Shelly Sand and Shingle (marine). Alluvium.
Pleistocene ...	River or Valley Drift.	Brickearth or Loam. Gravel.
	Plateau Drift (of doubtful age).	Loam. Gravel (various). Pebble Gravel.
	Glacial Drift ...	Boulder Clay. Loam. Gravel and Sand.
Pliocene ...	Upper Crag ...	Chillesford Beds (clayey). Red Crag.
Eocene ...	Bagshot Beds ...	Pebble-beds. Sand.
		London Clay.
	Lower London Tertiaries.	Oldhaven Beds. Woolwich and Reading Beds. Thanet Beds.
Upper Cretaceous	... ...	Chalk.

The divisions of the Chalk have not yet been traced, but whilst in the greater part of the county the Upper Chalk only occurs at the surface or at no very great depth, the Middle Chalk also crops out on the north-west. Some deep wells and borings have also reached the Lower Chalk, and in addition the following have been proved in like manner; but beneath the Cretaceous there is a great gap, and, whilst Jurassic Beds were probably pierced at Saffron Walden (*see* p. 353), we have no certain evidence, and we cannot chronicle anything else of post-Devonian age:—

Selbornian	Upper Greensand. Gault.
Lower Cretaceous.	Lower Greensand.
Devonian or Old Red Sandstone.	
Silurian or older.	

WATER-BEARING BEDS.

Turning now to the consideration of those of the above-mentioned formations which are notable as yielding water in Essex, we begin with the gravels and sands of the Valley Drift, of the Plateau Drift and of the Glacial Drift, which, for the present purpose may all be taken together, regardless of comparatively small differences in geologic age. All are deposits of one kind, and

mostly occur under like conditions, resting irregularly on whatever may happen to be below, and being of no great thickness as a rule.

Drift. Gravel and Sand.

On the whole these beds are probably the most pervious that we have to deal with here, and they are important as often being the only source from which a small local supply can be got, at a reasonable cost at all events. Sometimes, too, they yield a supplementary supply to that got from deeper sources. They cannot be neglected in such a county as Essex.

Of course, it is essential in dealing with these shallow supplies that regard shall be paid to protection from risk of surface-pollution, whether by the avoidance or the removal of things that tend to that danger. It must be remembered, however, that the passage of water through a great length of gravel or sand amounts to effective natural filtration.

The following remarks by J. M. Wood serve as an illustration of the amount of water that may exist in our gravels.[1] They follow a description of the springs near Colchester (*see* pp. 75, 78).

Taking the average yearly rainfall over the large gravel-tract as 20·15 ins., and assuming that 37 *per cent.* of this (7·45 ins.) "percolates into the formation, then each square mile will absorb, say, 107,864,229 gallons of water, equal to a daily yield therefrom, if conditions are favourable, of some 259,518 gallons." Taking the gravel-tract as 12 square miles "then the quantity contained therein will be . . . 1,294,370,748 gallons, equal to a daily supply therefrom of 3,546,216 gallons." The amount taken by the Corporation of Colchester "from all their springs . . . probably does not exceed, say, 550,000 gallons (a day) . . . consequently there is a considerable quantity of water escaping along the fringe of this plateau of gravel in the shape of visible and invisible springs other than those mentioned, and feeding the rivers and streams bounding the gathering ground."

Of course, the above high figures refer only to the amount of water that gets into the gravel: what can be got out is a very different thing, and it is only in certain places that a large amount can be got.

One of Mr. Wood's objects in describing the Colchester springs is to impress on communities that they may have "a supply of water within sight of their doors, and all that is needed to bring it into use is a little common sense combined with geological, medical, chemical, and engineering skill." The mixture is certainly a good one; but it is sometimes hard to bring it about. "Prejudice has existed in the past against so-called surface springs, but all water which we consume, whether it has been collected from the moors or the hill-side . . . or taken from rivers . . . or pumped from wells . . . has at one time or another been in contact with the surface. Even a well sunk into the open chalk is as liable to be polluted by man as a gravel supply, if not protected."

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[1] *Essex Naturalist*, 1912, vol. xvii, pp. 32, 33.

In speaking of Chelmsford, where he had to do work in saving waste of water, CUTHBERT BROWN has said that the gravel-subsoil "lends itself very much to water waste . . . and it had been remarked by some of the old residents in the district that their own private wells never ran dry, and this was afterwards found to be owing to the waste that was taking place in the Council's mains,"[1] the water from them going into the gravel which supplied the aforesaid wells. Truly a peculiar method of public supply!

T. S. DYMOND has made the following observations[2]:—

"The water obtained from wells sunk into gravelly pockets of [? in] the London-clay is often excessively hard, the hardness being partly due to sulphate of lime. In one such water from Wickford I found the permanent hardness was equal to 93 parts of sulphate of lime per 100,000, and another from Ingrave to 112 parts. In such waters, however, part of the hardness is invariably due to sulphate of magnesia."

"That such excessive quantities of sulphate of lime are not found associated with the Boulder-clay is sufficiently explained by its permeability to water. The rain water draining through the Boulder-clay dissolves from the surface and carries with it the sulphate of lime, and the water issuing from springs at the outcrop of the underlying gravel, contains appreciable, but not excessive, quantities of the salt."

DR. THRESH has remarked that "at Great and Little Braxted, Great and Little Totham, Wickham Bishop, and Tiptree Heath, where the Glacial gravel is raised and exposed so as to be beyond the influence of the Boulder clay," the water is "almost destitute of carbonate of lime. In the Chelmsford and Maldon districts these are the only parishes yielding such waters. In all others we find that most of the water in the gravel must have percolated through the Boulder clay which, in some places, is far more pervious than is generally supposed. The springs at Writtle, Roxwell, Chignall, and Ford End are at the edge of patches of gravel, most of which is covered with Boulder clay. As this latter contains a considerable amount of chalk, the water, in percolating through, dissolves a certain amount, and its temporary hardness, due to the dissolved carbonate of lime, is increased." Moreover, "waters obtained from wells sunk through the Boulder clay to the gravels and sands lying between this and the London Clay . . . contain from 10 to 30 grains of carbonate of lime per gallon."

"I have no evidence that there is any difference between 'Bagshot' and 'Drift' waters, except such as can be accounted for by the influence of the Boulder clay, or the proximity of villages with defective sanitary arrangements."[3]

It is clearly needless here to separate the small areas of Bagshot Beds and the still smaller ones of Crag from the widely distributed Drift Gravel and Sand, all being much alike, as regards water, and all coming above the London Clay.

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[1] *Journ. Inst. San. Eng.*, 1913, vol. xvii, pt. i, p. 34.
[2] *Essex Naturalist*, 1905, vol. xiv, p. 62.
[3] *Essex Naturalist*, 1893, vol. vii, p. 31.

Boulder Clay and London Clay.

Although the Boulder Clay cannot be classed amongst water-bearing formations, yet, in common with other clayey deposits, small amounts of water are occasionally got from this division of the Drift, and the following remarks thereon have been made by DR. THRESH: "In certain localities, I have observed a peculiarity of the Boulder clay water which . . . when freshly drawn, has the odour of rotten eggs . . . due to a trace of sulphuretted hydrogen; but how the gas is produced, and why peculiar to localised areas, I cannot explain. It is very probably formed by the reduction of a sulphate by some peculiar organism, or by dead organic matter. . . . The general public, however, invariably ascribe the smell to sewage pollution; but my analyses do not confirm this opinion. The smell very rapidly disappears if the water is left in an open vessel, the gas being oxidized by the exposure to air."[1]

The London Clay, too, on the whole is anything but water-bearing, yet some water is occasionally met with where sandy beds occur in it. The basement-bed generally consists of a few feet of more or less permeable material, and in former times water seems to have been got from this at some places; but it may be difficult to recognise this water apart from that got from the beds beneath.

DR. THRESH remarked in 1893 that in some places "we meet with waters containing much sulphate of magnesia. In such cases the water seems to be derived from small beds of sand in the London Clay. On the east of Galleywood Common we recently made a few trial bores, finding water at a depth of about twenty feet; but it contained so much sulphate of magnesia (Epsom Salts) as to be unfit for any domestic purpose. At Margaretting Tye there is a well (now closed) yielding such water, and at West Hanningfield there is a similar well. . . . What is the source of this magnesia? and are the beds of sand yielding such waters limited to the upper portion of the London Clay?"[2]

More detailed remarks on the chemistry of waters are given further on, pp. 15–37.

Lower London Tertiaries.

This varying set of sands, clays and pebble-beds is of more importance, from a water-supply point of view, in Essex than in any other county; and for the following reasons:—

Whereas in some parts of the London Basin the middle division only, the Reading Beds, is present, and often consists largely, sometimes almost wholly, of clay; in the southern part of Essex the top division, the Oldhaven or Blackheath Beds, is often present, and it consists of sand and pebble-beds; so also the lowest division, the Thanet Beds, is everywhere present on the south, and consists of sand on the west, but with some clayey beds on the east, where, however, as if to make up for this, the Woolwich Beds are in great part sandy.

Moreover, the total thickness of the Series is considerable, as

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[1] *Essex Naturalist*, 1893, vol. vii, p. 31.
[2] *Essex Naturalist*, vol. vii, pp. 31, 32.

compared with what is found in many other tracts, that is to say, in the southern part of the county, where, on the east, many borings show a thickness of 150 ft. or more, and as great a thickness as 181 ft. has been recorded.

Again, it seems that water in the Chalk passes up, under pressure, into the Tertiary sands, and often, whilst it is difficult to get water from the Chalk by boring, these sands have a fair yield. A boring that passes through sand more or less charged with water, on reaching the Chalk may easily avoid cutting any of the fissures along which water usually travels.

In Essex, therefore, the Lower London Tertiaries are second only to the Chalk amongst water-bearing formations.

Many years ago DR. MITCHELL, one of the pioneer-writers on wells, said, in a paper devoted to our county[1]:—" A sufficient supply of water is sometimes found in the first bed of sand (beneath the London Clay), but it is more often necessary to sink to that (Thanet Sand) resting immediately on the chalk, on reaching which a vast volume of water rushes up, and compels the well-digger to ascend precipitately to the surface."

This is interesting as illustrating the fact that in former times the sandy beds of the Lower London Tertiaries were recognised as the water-bearing beds, and that the Chalk was not as a rule penetrated to any great depth. Records of old wells, such as those at East Hanningfield (p. 145) and at Harwich (p. 184) show the same thing.

Now, however, we do not hear of well-sinkers being hastily driven to ascend, from the rapid inflow of water. Many more wells and much heavier pumping have presumably altered things. Indeed, of late years there has been a reversion to the Lower London Tertiaries as a source of water-supply, it having been found in many cases that the Chalk has failed to yield anything but a very small amount of water, as in the case of many of the wells of the Southend Water Company.

Chalk.

This, the thickest of Essex formations, must be regarded also as the chief one in the matter of water, though in many parts, where reached only at great depths, it fails to yield large supplies.

Water mostly travels through the Chalk along the joint-planes, more or less vertical planes that cut across the formation in various directions, though often there is one dominant direction. In the southern outcrop of the Chalk in Essex, as on the opposite side of the Thames, in Kent, the chief planes of jointing tend to run in a direction roughly from N.W. to S.E. It is clear, therefore, that it is only where these planes are not closed up, but form fissures, mostly very narrow, that water can flow along them in notable quantity. Where, therefore, the Chalk is subjected to the pressure of a great thickness of overlying beds, and where it has a more or less troughed arrangement, however slight, there is a tendency for the mass as a whole to be compacted, and its fissures to be closed.

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[1] *Proc. Geol. Soc.*, 1839, vol. iii, p. 133.

Moreover, where the Chalk is at a great depth it has to be reached by boring, the sinking of a very deep shaft being a costly matter. To get large supplies from the Chalk it is generally needful to cut a goodly number of the water-bearing fissures, and this can only be done by driving horizontal headings from a shaft; borings may easily escape from cutting fissures, passing down between them. It is doubtful, however, whether in most parts of Essex satisfactory results could be got by horizontal work in the deep-seated compact Chalk.

These joint-planes or fissures may reach for long distances, and therefore may carry water from very distant parts. Dr. Thresh has said:—"It is possible . . . that there may be at some point or points freely intercommunicating fissures extending into Kent and bringing water in quantity from that county into Essex. The water at Mucking, for example, corresponds much more nearly in character with Kent water than with any found in Essex, save at very distant points."[1]

One of the very few attempts to show the level of the top of the Chalk underground, beneath the Eocene Tertiary beds, over a considerable area, has been made for our county by W. H. Dalton,[2] who says:—"If the surface of the Chalk were a uniform plane the determination of its position with regard to sea-level of [at] any desired point would be one of the most simple geometrical problems . . . but the case is very much otherwise. Instead of a plane we have an elaborately-puckered surface."

This is illustrated by the map given, which is on the scale of ten miles to an inch. On this a set of more or less curved lines show the depth to the top of the Chalk, in relation to Ordnance Datum, in hundreds of feet, from 200 ft. above that level, in the north-western part of the county, to 600 ft. below it in the south-eastern part. "The straighter lines are faults whose existence is imperceptible on the surface of homogeneous clay, even where not concealed by drift, but which are sufficiently established by their effect on the Chalk contour-lines." Of course some of these lines might now be drawn somewhat differently, many borings to the Chalk having been made since this paper was read.

The lines show various flexures in the Chalk. One of these is "the great faulted undulation of Tiptree Heath" (*see* pp. 281, 312) which "has quite recently been again proved at Messing, and its course through Suffolk is traceable. . . . Along Tiptree ridge it is a faulted anticlinal for several miles. From Wickham Bishop it is traceable with less distinctness by Danbury to the south-west, its effects being complicated by a series of obliquely transverse flexures and fractures." Other cases are "the parallel fault from Walton to Prittlewell, the anticlinal of Mersea and Burnham . . . the east and west fractures from . . . Walthamstow to Burnham." These are all more or less from S.W. to N.E.

"The lines of flexure and fault of N.W.-S.E. trend are less regular, of shorter continuance and variable direction. . . ."

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[1] Report on the Water Supply of Essex, 1901, p. 17.

[2] The Undulations of the Chalk in Essex. *Essex Naturalist* 1891, vol. v, pp. 113-117, pl. iii. Partly reproduced in Dr. Thresh's Report on the Water Supply of Essex, 1901, pp. 17-19, plate.

"Altogether the Essex Chalk shows a range of elevation of about 1,200 feet from its greatest depression at Fowlness, over 600 feet below the sea-level, to the 600 feet above sea which, but for denudation, it would exceed in the north-western corner of the county."

MR. DALTON has noted corrections that should be made on his map from information given by borings in Foulness, where the Chalk might be reached at the depth of about 450 ft. below Ordnance Datum. This would affect the 400 ft., the 500 ft., and the 600 ft. contour-lines.[1]

This subject and that of underground water-level has been referred to, for the extreme south-western corner of Essex (West Ham, Woodford, Ilford), in the Geological Survey Memoir "Records of London Wells," 1913, in which three small maps are given, on p. 13, showing variations in underground water-level, one of which "strangely enough records a rise in the area about Lea Bridge" (p. 12).

Plate i. is a map (on the scale of 2 miles to an inch) of contours in the underground water-surface, from above Ordnance Datum to 25, 50 and 75 ft. below it. Plate ii. is a corresponding map of the Pre-Tertiary Chalk-surface, from Ordnance Datum to 100, 150, and 200 ft. below it.

It is of interest to note that HAROLD WARREN has written a paper on Water-levels in the Chalk near Royston, dealing with those parts of Cambridgeshire and Hertfordshire which adjoin the NW. corner of Essex, and part of which indeed was once in Essex (see above, p. 2). A tabular record of many wells is given, with a map and four sections, two of which show the fall of the underground water-plane from the top of the Chalk escarpment northward toward the springs at the foot.[2]

Another piece of work of a like sort, referring to another border-county, was published late in 1913. In a paper on the Chalk of Suffolk,[3] P. G. H. BOSWELL gives a map "showing Contour Lines for the Top of the Chalk," in which he extends those lines southward into the north-eastern part of Essex. The line for 50 ft. below Ordnance Datum runs from a little north of Manningtree to a little north of Colchester; that for 100 ft. from the coast south of Harwich to north of Weeley; that for 150 ft. from the coast north of Walton-on-Naze to about half-way from that place to Weeley; and that for 200 ft. in the sea near Walton.

To the above published information we are now able to add a much more detailed account for part of the north-western corner of Essex.

The Underground Water-level in the Chalk around the Head-waters of the Stort and of the Cam.

An investigation of this tract was made for the promoters of the proposed South Essex Water Board Bill in 1900. MESSRS. H.

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[1] *Essex Naturalist*, vol. xv, 1908, pp. 124, 125.
[2] *Trans. Herts Nat. Hist. Soc.*, 1897, vol. ix, pt. vi, pp. 209-214, pl. vi.
[3] *Journ. Ipswich Field Club*, 1913, vol. iv, pp. 17-26, map. The map, with slight difference, in *Quart. Journ. Geol. Soc.*, 1914, vol. lxix, pl. liv.

ROFE & SON, who did the work, have kindly put it at our disposal, with a map (Ordnance) on the scale of an inch to a mile, from which Plate 1 has been reduced. H. J. ROFE has also given the four following descriptive paragraphs:—

The area over which the observations were taken reached roughly from Bishop's Stortford, on the south, to Saffron Walden, on the north, and from Royston, on the west, to Radwinter on the east.

The contour-lines of water-levels at each 25 ft. above Ordnance Datum, marked on the map, show the level of saturation in the Chalk of the district in April, 1900.

These lines are deduced from the level of the water in the 65 wells shown by numbers on the map (Plate 1), with the water-levels, and are set out in the following table.

The fixed point from which the depth of the water was to be measured at each well was accurately levelled beforehand, and the measurements were made between the 12th and 18th of April (57 of them on the 12th and 13th); so that they were practically simultaneous, and therefore the effect of seasonal fluctuation was eliminated.

We have therefore a record of the precise state of things at a definite time, with hardly a chance of change as between one place and another.

No. on Map.	Site of Well.	Water-level in feet above Ordnance Datum.
1	Little Chesterford Post Office	129.29
2	Redlands Hall, Chrishall	157.5
3	New Buildings, Great Chrishall	135.84
4	Heydon Lane Bottom, Chrishall	249.66
5	Poplar Farm, Elmsdon	148.94
6	Strethall Hall	179.07
7	Elmdon	220.7
8	,, Vicarage	222.63
9	Chrishall Parsonage Farm	240.82
10	,, Village	187.79
11	Barley, near Fox and Hound Inn	171.12
12	,, Mr. Wilkerson's	190.85
13	,, Next to Smithy	190.64
14	Barkway, Newsells	216.21
15	,, Newsells Village	218 95
16	Shaftenhoe End, Barley	206.61
17	Little Chishall, Manor House	242.28
18	Chrishall, Lower Farm	276.97
19	,, near Nursery	266.34
20	Wenden Lofts, Mill House	247.
21	Elmdon Lee	198.98
22	Littlebury, How Hall	181.73
23	,, Avenue Cottage	166.63
24	,, Windmill Pump	152.65
25	,, opposite Smithy	140.98
26	Saffron Walden, South of New Houses ...	155.73
27	,, ,, Waterworks	151.82
28	,, ,, Sewersénd Road	157.52
29	,, ,, Thaxted Road	158.31
30	,, ,, Pleasant Valley	158.86
31	Radwinter Brewery	251.03
32	Wendens Ambo, near School	180.34
33	,, ,, near Bell Inn	180.54
34	,, ,, Clanverend Bridge	188.84

No. on Map.	Site of Well.	Water-level in feet above Ordnance Datum.
35	Langley, The Hall...	252.62
36	,, Brick House	254.78
37	Arkesden, Green Man Inn	215.79
38	Debden Deans	199.2
39	Clavering, Hill Green	225.67
40	,, Fox and Hounds Inn	232.65
41	,, near Church	234.32
42	,, The Hall	236.63
43	Berden, near Post Office...	234.37
44	,, Rookes Farm	230.66
45	,, Woodside Cottage	230.22
46	Quendon, The Views	221.91
47	,, Cottages, near Broomwood	219.37
48	Ugley, Chequers Inn	220.86
49	,, Cottage, Vicarage Lane	219.61
50	Manuden	219.33
51	,, Catherine Buildings	219.13
52	,, Battles Farm	225.07
53	Furneux Pelham, East End	245.97
54	,, ,, Brewery	250.18
55	,, ,, opposite Clay Chimneys ...	248.06
56	Albury Patmore Heath	242.73
57	,, Clapgate, Royal Oak Inn...	236.43
58	Stansted Waterworks (Pumping)	211.06
59	,, New Almshouses	210.69
60	Elsenham, Public Well	220.81
61	Bishop's Stortford Waterworks (Pumping) ...	181.47
62	Little Hadham, Bury Green, Village Well ...	206.62
63	,, ,, Stone Farm	214.7
64	,, ,, North of Village	218.77
65	Bishop's Stortford Workhouse	194.43

Postcript to p. 9.

When the well at Hogwell Siding, Stow Maries (see p. 274), was completed, the water was soft and alkaline, like waters from the sands of the Lower London Tertiaries. After a time it became so hard that the people using it complained. Dr. Thresh examined the sunk portion of the well and came to the conclusion that water was getting in from the London Clay, which in this neighbourhood is intersected in various directions with thin laminæ of calcium-sulphate. The brickwork was improved, and the water got much softer. The hardness was due both to calcium-sulphate and magnesium-sulphate.

On the roadside near Great Hayes Farm, E.N.E. of Hogwell, is a bored well, long disused. Dr. Thresh had this opened and found the water so loaded with magnesium-sulphate (Epsom Salts) that it could not be used for any purpose.

The owner of the farms had a well bored on the marshes, at Little Hayes Farm, the water from which was, Dr. Thresh believes, satisfactory, but the analysis cannot be found.

THE CHEMISTRY OF ESSEX WATERS.

General Remarks.

The most interesting part of this subject is the great difference in the character of the deep-seated Chalk-waters, got from tracts where the Chalk is deeply covered by Tertiary Beds, compared with the character of the waters where the Chalk is at or comparatively near the surface.

This difference, which consists chiefly in the replacement in the deep waters of the carbonate of lime of the ordinary Chalk-water by alkaline carbonates and in increase of chlorides, has often been referred to, with various explanations, and a general statement of the case has been given in a Geological Survey Memoir.[1]

Of papers referring to the subject in the last century (but not referring to Essex), there is no need to notice more than two, which are specially concerned with it, and both of which were published in the same year, 1887. Of these the first[2] has been laid under contribution in the Memoir referred to; but the second unfortunately had not been noticed when that Memoir was written,[3] an omission partly righted some years later.[4]

In the Memoir on the Geology of London, etc., in treating of the difference of the two sets of water, it was suggested that "from communication between the Chalk and the overlying Tertiary sands, the water in the former has become charged with some of the saline constituents of those sands, whether original, or produced by chemical alterations going on at great depths, where the beds are saturated with water." Mr. Hayward, however, doubted "whether the quantity (of salts in the Tertiary sands) is sufficient to produce so widespread an effect"; but probably he did not think of possible chemical changes at great depths.

Mr. Hayward points out that the examination of many analyses shows that whilst the total solid matter dissolved is larger on the average in water from covered Chalk than in water from practically bare Chalk, yet the average hardness is very much less. "This want of relation between the amount of solid constituents and the hardness of the water indicates a totally different mineral constitution in the two kinds of water."

Mr. Warington, whose elaborate paper (which deals also with various other subjects), was based on Hertfordshire waters, concludes that the low proportion of chlorides in the waters got at no great distance from the Chalk-escarpment may have been brought about by reason that the Chalk, in this high district, "has been in the course of ages washed very thoroughly by the percolation of rain, and the chlorides originally present in the rock . . . have been almost completely removed." The water

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[1] The Geology of London and of Part of the Thames Valley, 1889, vol. i, pp. 514-516, 533, and table opposite.

[2] R. B. Hayward. On the Water in the Chalk Beneath the London Clay. *Middlesex Nat. Hist. Soc.*, pp. 48-63.

[3] R. Warington. A Contribution to the Study of Well Waters. *Journ. Chem. Soc.*, vol. li, pp. 500-552.

[4] W. Whitaker. Chalk Water in Hertfordshire. *Trans. Herts Nat. Hist. Soc.*, 1898, vol. x, pt. i, pp. 12, 13.

in wells further down the slope (and the dip) show an increase of chlorides, as should be the case according to the above.

Of late years the discussion of the difference between the waters from wells where the Chalk is at a great depth and those where the Chalk is at or near the surface has practically become an Essex question, as may be seen from the list of papers toward the end of this Memoir.

The salinity and alkalinity of some of the deep well-waters was alluded to by Dr. Thresh in his papers of 1893[1] and 1900, in the latter of which a table of the saline constituents of deep wells in Essex was given.[2] In the first year of the present century Dr. Thresh treated the subject in detail,[3] giving a map on which wells yielding Chalk-water are distinguished from those yielding soda-water (=alkaline).

Finally Dr. Thresh's paper read to the Essex Field Club and privately printed in 1912 is reproduced further on, p 20, and he contributes the following description to p. 37:—

Having studied the different types of Chalk-waters for several years, I am strongly convinced that the character of the water in every locality can be explained by assuming that it is a typical hard Chalk-water mixed with a proportion, in some cases exceedingly small, in other cases comparatively large, of sea-water, and that the mixed water has been more or less modified in character by percolation through the various sands beneath the London Clay. In proof of this theory one may cite the acknowledged fact that sea-water is known to be gaining access to the Chalk in many places in the tidal rivers and sea bounding the county, and by proving that mixtures of Chalk-water and sea-water when filtered through Thanet Sand result in the production of the alkaline water so characteristic of the waters from the Sands and Chalk where overlaid by Tertiary Beds; and further proof is the fact that both bromides and traces of iodides can be found in these waters and in about the same proportion as the calculated admixture would indicate. In certain places the Lower Tertiaries yield limited amounts of water containing large quantities of magnesium- and calcium-sulphates. These salts, I believe, to be derived from deposits of these crystalline salts in the London Clay. Large crystals of calcium-sulphate are found in the clay in certain localities (Clacton, for example), and in others exceedingly thin laminæ of small crystals of this mineral are found traversing the clay in all directions. Possibly in the deeper layers of clay magnesium-sulphate is also present, since surface-wells in the clay always contain a certain amount of this salt, which must be derived from the clay. The salt is so soluble, however, that it could not be expected to occur in crystals anywhere near the surface of the ground. These magnesia-waters are found chiefly, if not exclusively, just below the base of the London Clay, and where bores have been carried deeper and pumping has been continued some time the salts have disappeared.

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[1] *Essex Naturalist*, vol. vii, pp. 33-36.

[2] *Trans. Brit. Assoc. Water. Eng.*, vol. iv, pp. 26-33.

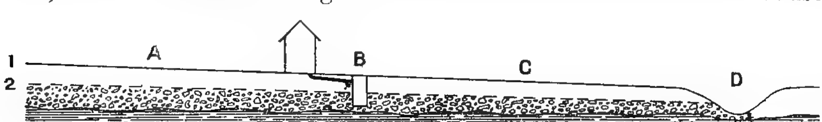
[3] Report on the Water Supply of the County of Essex, 1901, pp. 25, 34-41.

WATERS FROM SAND AND GRAVEL DRIFT.

Where not overlaid by Boulder Clay the water derived from these beds is of very moderate hardness, and usually a large proportion of this hardness is removable by boiling. The chlorides are usually small in amount, but apparently these water invariably contain appreciable amounts of magnesium-chloride. On the same gravel-patch the chlorine-contents remain, as a rule, fairly constant so long as the sources are remote from sewage-pollution, but if there is an aggregation of houses on the patch, without efficient sewerage, the amount of chlorides increases as the ground-water approaches the inhabited area and reaches a maximum as the water reaches the distal boundary on its way to its natural cutlet.

Nitrates are invariably found in waters from these Glacial and Post-glacial deposits, the amount depending upon the extent to which the ground-surface is cultivated and the extent to which it is permeated by sewage. These waters may contain as much as one part of nitric nitrogen in 100,000 parts and yet be free from sewage-pollution, and that they are perfectly wholesome is proved by the mortality- and sickness-statistics of considerable communities having public water-supplies of this character. Many analysts still condemn waters with this peculiarity, and such analysts would doubtless condemn many excellent public supplies in the county. These salts increase *pari passu* with the chlorides in the proximity of habitations, and in recording series of analyses of waters from a large number of wells on the same gravel-area, it is noteworthy that the hardness of the water also varies with the chlorides and nitrates, the variation, however, being limited to the so-called 'permanent' hardness.

At points away from the influence of farm-yards, drains and cesspools, the sands and gravels usually yield a reasonably soft and a wholesome water. In selecting a site for sinking a well therein the direction of flow of the ground-water must be observed; it is usually in the direction of the nearest watercourse. A well sunk at any point where polluting matter can only reach the ground-water after it has passed the well will probably yield a good water, whereas if sunk elsewhere there will be a risk of pollution. This is so important a point, and is so often neglected by builders and architects that it deserves the emphasis of diagrammatic illustration, as below. The flow of water being from A to D, a well sunk on the side of the house towards A would yield a good water, whereas if sunk on the side C the water would be liable to contamination. In this diagram the cesspool and drains are shown in a proper position. Had the cesspool been placed at A, then the whole of the ground-water under and around the house



1. Soil etc. 2. Gravel. 3. Clay. B. Cesspool. D. Stream.

would run the risk of pollution and a safe water could only be obtained by sinking a well 50 or 60 ft. beyond A. In most of our Essex gravels polluting matter disappears very slowly. In many

cases where farm-yards have been cleared so that the farm-house could be turned into a private residence, water obtained from shallow wells in the neighbourhood continues to improve for years afterwards. In a village on the gravel which was sewered over 20 years ago on account of an epidemic of typhoid fever, the wells still yield water which is undeniably contaminated.

Large quantities of water are obtained from gravel-springs at Lexden and form part of the water-supply to Colchester (*see* pp. 78). Similar springs at Great Bentley supply Clacton (*see* p. 77). Springs arising at the edge of the Danbury gravel supply large areas in the Chelmsford and Maldon Rural Districts (*see* p. 76), and these waters, analyses of which are recorded (pp. 349-351), are typical of the purest gravel-supplies. Spring-waters also supply Felsted and part of Chelmsford Borough, but here the gravel is capped with Boulder Clay which materially affects the character of the water. Lime-salts and magnesium-salts are present in considerable amounts, and often in such quantity as to render the water too hard for domestic and many other purposes. Occasionally these waters contain a considerable quantity of magnesium-sulphate (Epsom Salts) sufficient to exert a laxative effect upon the consumers.

Two instances have come under our notice of waters from shallow wells containing an inordinate amount of common salt. The owner of a large house on the edge of a patch of Boulder Clay at Mountnessing sought to increase the water-supply by sinking a new well. At the depth of a few feet water was obtained which was distinctly brackish, and it did not improve as the depth increased. The well had to be abandoned. A hundred yards away the water obtained, though limited in amount, was quite sweet, containing but little salt. More recently a well was sunk at Tolleshunt D'Arcy with exactly the same results. No explanation of the phenomena has yet been found. In the latter case the results were the more disappointing, since of several spots located by a 'water-finder,' this was the only one in which any water was found, and it turned out to be unusable.

In certain localities the sands and gravels yield a water which has a decided action upon lead, and cases of lead-poisoning have occurred at Galleywood, Great Totham and Childerditch, from the use of shallow well-water raised by means of a lead pump with leaden suction-pipe. These waters were all hard, but the hardness was almost entirely due to sulphates of calcium and magnesium, carbonates being present in very small quantity. The introduction of a load of clean chalk into the wells not only improved the quality of the water, but also prevented the plumbo-solvent action, from which it may be inferred that this action was chiefly due to the free carbonic acid contained in the water. When this has disappeared, the chalk having taken up the acid to form calcium bicarbonate, lead is no longer attacked. Such waters also act upon iron or zinc (galvanised iron), rendering the water opalescent (only after boiling if zinc alone is dissolved), and the action can usually be prevented and a bright water obtained by putting a sufficient quantity of clean chalk into the well.

In the Boulder Clay area the water obtained from wells not unfrequently has a decided odour of sulphuretted hydrogen, and

when such is the case, naturally perhaps, the inhabitants around regard it as being sewage-polluted and refuse to use it, although the rotten egg odour disappears very quickly if the water is exposed to air. Samples of this kind of water have reached the County Laboratories from all parts of the county, and almost invariably the odour has disappeared during transit. The amount of sulphuretted hydrogen required to impart an appreciable odour is almost infinitesimal, and it so rapidly takes up oxygen from the air, forming an inodorous sulphur-compound, that when the water is allowed to stand an hour or more in a pail it becomes odourless. Such waters are generally of considerable organic purity, and after the odour has passed off, they may be well adapted for domestic purposes. Usually the wells continue to yield a stinking water, but this does not appear to be invariably the case. For example, a well was sunk to supply water to two new cottages at Great Waltham. The builders' men made no complaint about the smell, and the pump was fixed over a sink in the wash-house. The water submitted for analysis had no odour and the necessary certificate for habitation was granted by the sanitary authority. The cottages were let, and immediately there was an outcry about the water. The odour of rotten eggs was so overpowering in the wash-house when the water was being pumped that women were made sick. The well was uncovered and left quite open to the air. This greatly improved the character of the water, and in about two years it was so satisfactory that the well was again covered in, and the odour has not been noticed since.

It is probable that the production of this odour is due to the presence of certain bacteria which derive their oxygen from that present in sulphates, in the absence of dissolved oxygen in the water. The treatment of such wells with chlorinated lime, to destroy all bacteria, has been recommended, and the subsequent waste of water until the chlorine has disappeared. No record is available, however, to show that this treatment has proved permanently successful. It certainly always removes the odour for a time.

WATERS FROM THE LOWER LONDON TERTIARIES.

Water derived from the Lower London Tertiaries at their outcrops does not seem to differ materially from that derived from shallow wells in the Glacial gravels and sand, but at a distance from the outcrop, where covered by London Clay, waters of two entirely different types are obtained. The one is an alkaline water exactly resembling that found in the Chalk and which will be referred to later, the other is a water which contains sulphates of calcium and of magnesium, often in excessive quantities. The latter is usually derived from the more superficial beds, and if this course can be cut out in tubing the well the lower beds of Thanet Sand usually yield the better alkaline water. In some cases, however, even the water in the Thanet Sand seems impregnated with these salts. Occasionally also the water may be highly ferruginous, as at Stanford-le-Hope, but this is very rare.

In the area between the estuaries of the Blackwater and of the Crouch wells yielding the very hard saline water are common (*see* analyses of waters from Althorne, etc.). These walls were sunk a

little over a century ago, at which period a boring of 300 ft. could be made, and lined with sheet iron tubing, for a sum not exceeding £100. A short time ago an account for such a well was preserved at Cold Norton Church, and probably is there still. Although many of the wells yielded a water too hard for washing-purposes, and acting as a mild aperient to people drinking it, the water was useful for many purposes, and the wells were retained in use until quite recently. Some still can be found, but the provision of an abundant supply of good water from the Danbury gravel, distributed by means of mains throughout that district, has caused the deep wells to be abandoned. The clay in this locality is impregnated with calcium-sulphate which can be seen in most delicate layers, intersecting the clay in all directions. Possibly at greater depths, where the clay has not been so largely washed out by the rain, the intercalating layers may include some magnesium-sulphate also.

In more modern wells, where such water has been struck, the deeper boring, if properly lined, has yielded water of the second type, very soft and free from sulphates of magnesium and of calcium; but often the effect of the upper water-bearing stratum is felt, the deeper-seated water having the character of a mixture of the two waters in varying proportions. In one instance, where the water from the Thanet Sand was markedly affected by the water from the higher beds, continuous pumping for many weeks resulted in the water becoming softer and softer until the presence of the water from the upper source could no longer be detected. Wells yielding both the above mentioned types of water were often found within short distances of each other. For example, at Mundon, one farm on the marshes would be found to have a well yielding excessively hard water, whereas a similar well at the adjacent farm would yield an exceedingly soft water. At Bulphan Fen wells yielding both types of water are still in use (*see* Analyses). Possibly the calcium-magnesium-sulphates are derived from the London Clay. Such waters occur, at East Hanningfield and Rettenden for example, in the little brooks fed by surface-water from the clay-land around.

DEEP-SEATED WATERS FROM THE CHALK AND THE LOWER LONDON TERTIARIES.

The soft waters obtained from the Thanet Sand and Chalk over a great part of Essex all contain sodium-carbonate, and almost invariably also a considerable amount of sodium-chloride (common salt), and the origin of these salts has been discussed by both geologists and chemists. One of us has made an especial study of the subject and recently contributed a paper on 'The Alkaline Waters of the London Basin' to the Essex Field Club. As the paper has not appeared in the Field Club's Publication it is reproduced here with slight changes.

It is now over 20 years since the writer became acquainted with the somewhat curious character of the waters derived from the Chalk and Thanet Sand in various parts of Essex, and during the last 12 years somewhat detailed analyses of all deep well-waters concerning the source of which any reliable information could be

obtained have been made. In 1901 a report on 'The Water Supply of the County of Essex' was published, and included therein a map showing that to the east of a curved line passing from Dedham in the north to Barking in the south the waters derived from the Chalk (save at the Purfleet outcrop) were soft and contained more or less salt and sodium-carbonate, whereas on the west of this line the waters had the ordinary character of Chalk-waters, that is, they contained very little salt and were free from sodium-carbonate, but contained a considerable quantity of chalk in solution and were therefore hard. It was also pointed out that in many localities the beds between the base of the London Clay and the top of the Chalk yielded waters containing an excessive amount of lime- and magnesium-salts, chiefly sulphates.

In the map above referred to the dotted line is said to suggest a probable fault in the Chalk. In some cases the marked difference in the character of the water derived from wells not more than, perhaps, a mile apart, seems to indicate the presence of a fault, but there is no other evidence in support of this suggestion, and my further investigations lead me to conclude that it is not necessary to assume the presence of a fault to account for the facts observed.

All the observed results admit of another explanation. So long as the water in the Chalk contains carbonic acid it continues to dissolve the chalk and open out the fissures. When all the acid has been used up in dissolving the calcium-carbonate it no longer possesses the power of opening out the fissures, and as the chalk becomes more compressed by the superincumbent mass of sand and clay it becomes so dense as almost to be impervious. Beyond this point therefore the water cannot travel in the Chalk, and it comes up through the fissured chalk into the sands above and then becomes exposed to their softening action. The compact chalk acts very much like a fault would do, assuming a solid impervious stratum abutting upon a pervious one.

It is not proposed to dwell so much upon the geological aspect of the question as upon the varying character of the waters derived from the Chalk and Thanet Sand in different parts of the London Basin, but more especially in Essex, and of offering an explanation for the variations in character.

The nature and progress of this change is well exemplified by the following analyses of waters taken from wells sunk into the Chalk at various places, Table 1.

Well No. 1 is on the outcrop of the Chalk. Well No. 2 is nearer the Chalk-outcrop than well No. 3, and the latter therefore has a greater covering of Tertiary beds. Wells Nos. 4 and 5 are bored through a considerable thickness of London Clay. At Lambeth we are approaching the Chalk-outcrop in Kent and Surrey. The following points are to be noted:—

1. The decrease in the calcium-carbonate up to London and its increase towards Kent.

2. The appearance of sodium-carbonate and its increase towards London and decrease towards the Southern outcrop.

3. The disappearance of calcium-sulphate in the waters under the London Clay.

TABLE 1—In parts per 100,000.

	1 Chalk. Eton.	▪ Chalk. Datchet.	3 Chalk. Datchet.	4 Chalk. Shepherds-bush.	5 Lon Chalk. Strand.	6 don. Chalk. Lambeth.
Calcium-Carbonate ...	21·8	16·3	14·7	5·	3·	12·75
Calcium-Sulphate ...	6·4	—	—	—	—	—
Calcium-Chloride ...	—	—	—	—	—	—
Magnesium-Carbonate	—	3·6	3·1	3·5	2·1	7·85
Magnesium-Sulphate	—	—	—	—	—	—
Magnesium-Chloride	2·3	—	—	—	—	—
Sodium-Carbonate ...	—	3·4	5·6	21·6	12·8	6·9
Sodium-Sulphate ...	—	7·6	7·6	24·1	18·1	11·1
Sodium-Chloride ...	1·1	5·8	5·6	22·6	18·2	14·4
Sodium-Nitrate ...	3·5	1·3	1·2	—	—	—
Silica, etc.	1·4	1·4	1·9	·6	1·2	1·
Total	36·5	39·4	39·7	77·4	55·4	54·
Hardness	30°	22°	18°	8°	5°	20°

TABLE 2—In parts per 100,000.

	Foxearth.	Halstead.	Bocking.	Braintree.	Witham.	Billericay.
Calcium-Carbonate ...	31·	25·3	21·9	5·3	2·8	1·8
Calcium-Sulphate ...	—	—	—	—	—	—
Calcium-Chloride ...	—	—	—	—	—	—
Magnesium-Carbonate	—	2·3	4·4	5·5	1·2	2·8
Magnesium-Sulphate	6·6	2·9	—	—	—	—
Magnesium-Chloride	1·6	·2	—	—	—	—
Sodium-Carbonate ...	—	—	3·1	19·8	26·7	26·3
Sodium-Sulphate ...	—	—	9·	11·8	10·8	9·4
Sodium-Chloride ...	4·5	14·	28·	67·2	78·3	36·5
Sodium-Nitrate ...	·2	·4	·2	·2	·2	·2
Silica, etc.	2·	·9	1·	·2	·5	1·
Total ...	45·9	46·	67·6	110·	120·5	78·
Hardness	40°	32°	26°	11°	5°	5°

TABLE 3—In parts per 100,000.

	1 10 per cent. sea-water.	2 Chalk. Manning-tree.	3 Chalk. Clacton.	4 Layer 568 ft.	5 Marney. 900 ft.	6 Mersea.
Calcium-Carbonate ...	·8	23·5	5·3	1·4	6·3	5·5
Calcium-Sulphate ...	13·3	—	—	—	—	—
Calcium-Chloride ...	—	—	—	—	—	—
Magnesium-Carbonate	—	6·5	4·2	·4	3·8	5·2
Magnesium-Sulphate	21·9	7·2	—	—	—	—
Magnesium-Chloride	36·7	1·8	—	—	—	—
Sodium-Carbonate ...	—	—	22·	39·1	29·2	32·5
Sodium-Sulphate ...	—	—	16·1	12·7	12·4	22·9
Sodium-Chloride ...	267·6	22·9	61·7	66·3	144·3	136·8
Sodium-Nitrate ...	—	·2	2·6	·6	—	—
Silica, etc.	—	2·7	2·6	1·5	—	·6
Total ...	357·	64·8	114·5	122·	196·	203·5
Hardness	abt.100°	45°	11°	2°	11°	12°

4. The appearance of sodium-sulphate in the waters from under the London Clay.

5. The increase and decrease in the amount of sodium-chloride.

6. The whole series showing a marked change in the character of the Chalk-water as the distance from the outcrop of the Chalk increases.

The next Table (2) includes typical analyses of samples of water taken in Essex along a line almost north and south from the bare Chalk at Foxearth to Grays,[1] where the Chalk again outcrops. Note again the amount of salts of calcium and of magnesium in the Chalk-waters at and near the outcrop, the diminution of this amount as the Chalk gets deeper and the corresponding increase in the carbonate and sulphate of sodium, together with the increase in the amount of common salt.

The Table shows, however, that whilst the carbonates and sulphates of sodium increase approximately in proportion to the decrease in the corresponding salts of magnesium and calcium, the amount of common salt seems to bear no relation to any of the other constituents. This is better brought out in Table 3, which refers to a localised area which has recently had to be studied somewhat fully, the Tendring Hundred, Mersea Island, and the Tollesbury districts. In analyses of waters from about 50 deep wells in this area the salt varies from 23 to 180 parts (or probably more) per 100,000, and it will be noted that some of the waters containing least salt are derived from wells near tidal estuaries, whilst many of the waters containing much salt are miles inland. The analyses of certain of the waters, however, indicate that tidal water is gaining access. This is well marked in the analysis of the Manningtree waters, No. 2 on Table 3. The Geological Survey has referred to wells at Ramsey, Pewit Island, Frinton and other places which yielded brackish water and were apparently abandoned. DR. COOK, Medical Officer of Health for the Tendring district, informs me that at Walton a well was bored and the water found to become more salt as the depth increased, the figures being:—At 100 ft., salt per 100,000 parts of water, 257 parts; at 200 ft., 258; at 300 ft., 293; at 360 ft., 308.

A well sunk at Clacton gave the results No. 3 on Table 3. The yield of water was trifling and upon continuous pumping the water became so brackish that it was abandoned. The water which rose naturally in the bore was comparatively soft, and contained sodium-carbonate and no more salt than the deep well-waters of Mid-Essex. A sample of the water after continuous pumping was not sent for analysis, but the engineer stated that it was so salt that no analysis was necessary to show that it was too brackish for domestic use.

There is no doubt that in this area the water varies in character at different depths. The salt in the Walton water shows this as do also the analyses of waters taken from borings recently made at Layer Marney, Nos. 4 and 5 (Table 3). The yield at 568 ft. was very limited, under 200 gallons per hour, and the boring was continued to 900 ft. and blasts of dynamite used, but the yield

[1] The analysis of Grays water will be found on Table 7, No. 6.

of water was not materially increased and the proportion of salt increased to such an extent that the water was useless.

Layer Marney is so far from the sea that it appears difficult to ascribe this increase in the amount of salt to any direct influx of sea-water, but my impression is that sea-water or tidal water is gaining access to the Chalk in the Thorpe-le-Soken area and at and near the Chalk-outcrop in the Stour Valley. The proof that these saline waters are derived from an admixture of sea-water and Chalk-water is, I think, proved by the analyses of mixtures of Chalk-water and sea-water after passing through a filtering medium which can remove the salts of calcium and of magnesium more or less completely substituting sodium and potassium in their place. The mere proximity to the sea does not enable anyone to say whether a water will be salt or not, as a well near the coast may or may not contain an excessive amount of salt. For example, compare typical waters from Brightlingsea with those from Mersea and Tollesbury.

Several experiments with mixtures of sea-water and Chalk-water have been made to show the effect of the softening process which will be described presently, and Table 4 is designed to show how the various waters in the London Basin can be imitated by mixing Chalk-water with sea-water and then submitting them to this peculiar treatment.

Varying proportions of Chalk-water and sea-water were mixed, a portion reserved for analysis and the remainder filtered through Thanet Sand of varying thickness and of varying activity so as to remove a portion or nearly the whole of the salts of calcium and of magnesium. It will be observed that these salts have been more or less completely removed and that the resulting filtrates are exactly of the type of the waters in the Tendring area as exemplified by the Tollesbury sample.

It would be difficult to regulate the rapidity of filtration or to vary the thickness of the filtering medium so as to remove exactly the right proportion of the salts of calcium and of magnesium, but as we know that these can be removed to any desired extent the effect of the filtration can be easily calculated.

Table 5 shows how a mixture of 2 per cent. of sea-water with 98 per cent. of Chalk-water from Halstead would be altered by filtration through different thicknesses of sand.

Braintree is about half-way between Halstead and Witham. Assume that the water in the Chalk at Halstead becomes mixed with 2 per cent. of sea-water on its way to Braintree and at the same time is traversing the Thanet Sand and becoming softened. Then the result at one stage would be the water (2) which, as will be seen, bears the closest possible resemblance to the Braintree water (3). Travelling onwards towards Witham the water would become still softer, more of the salts of calcium and of magnesium being removed, and at some point a water having the composition of No. 4 would result, and this it will be noted bears the closest resemblance to the Witham water No. 5.

Towards Chelmsford the water would become still softer, which is actually the case, but as the water in the Chelmsford area contains a little less salt we have to suppose that dilution with a less saline water is taking place, probably from the neighbourhood of

TABLE 4.

SEA WATER AND CHALK WATER—In parts per 100,000

	Untreated.	Treated.	Untreated.	Treated.	Untreated.	Treated.
Calcium-Carbonate ...	12·7	2·	25·2	1·	24·3	3·8
Calcium-Sulphate ...	29·	—	—	—	—	—
Calcium-Chloride ...	1·	—	—	—	—	—
Magnesium-Carbonate	—	1·7	2·5	·5	3·4	·4
Magnesium-Sulphate	—	—	12·3	—	8·9	—
Magnesium-Chloride	10·3	—	6·6	—	—	—
Sodium-Carbonate ...	—	9·	—	31·8	—	29·2
Sodium-Sulphate ...	—	30·3	—	16·3	—	15·6
Sodium-Chloride ...	103·5	118·8	113·1	126·2	72·	73·
Sodium-Nitrate ...	—	—	—	—	—	—
Silica, etc.	—	3·2	1·	2·2	—	2·
Total ...	156·5	165·	161·	178·	111·	124·
Hardness	40°	4°	40°	1½°	33°	5°

TABLE 5.

HALSTEAD CHALK WATER + 2 PER CENT. SEA WATER—In parts per 100,000.

	1 Untreated.	2 Treated.	3 Compare with Braintree.	4 Further treated.	5 Compare with Witham.
Calcium-Carbonate ...	27·3	5·3	5·3	2·8	2·8
Calcium-Sulphate ...	1·8	—	—	—	—
Calcium-Chloride... ...	—	—	—	—	—
Magnesium-Carbonate ...	—	5·5	5·5	1·4	1·2
Magnesium-Sulphate ...	8·	—	—	—	—
Magnesium-Chloride ...	9·8	—	—	—	—
Sodium-Carbonate ...	—	16·7	19·8	25·2	26·7
Sodium-Sulphate... ...	—	11·4	11·9	11·4	10·8
Sodium-Chloride	63·3	75·2	67·2	75·2	78·3
Sodium-Nitrate	·3	·3	·2	·2	·3
Silica, etc.	1·	1·1	1·2	1·3	·4
Total	111·5	115·5	111·1	117·5	120·5
Hardness	—	12°	12°	5°	5°

TABLE 6—In parts per 100,000.

CHLORINE AND BROMINE IN SEA WATER AND ESSEX DEEP CHALK WATERS.

	Chlorine in 100,000 parts of water.	Ratio of bromine to chlorine.
Sea Water, Clacton	1885	1 to 274
* ,, Blackwater Estuary ...	1850	1 to 328
,, ,, ,, ...	1850	1 to 378
Tollesbury Deep well Water	75	1 to 225
*Chelmsford Deep well Water	35	1 to 250
,, ,, ,, ...	35	1 to 322
Maldon Deep well	50	1 to 442
Tillingham Deep well	76	1 to 317
Barking Deep well	324	1 to 312

* Two separate determinations of each water showing variation in results due to difficulties in analysis.

Saffron Walden. By varying the source of the Chalk-water and the proportion of sea-water, I think every water from the Chalk and Thanet Sand in Essex and under London could be imitated.

Assuming that the salinity is due to sea-water, then the bromides which exist in sea-water should be capable of detection in the saline waters. This proved to be the case, but when it came to the question of estimating the amount great difficulties were encountered, and have not yet been entirely surmounted. The figures in Table 6 are given with some reluctance, but they can be depended upon for the purposes of comparison:—

The proportion of bromides to chlorides is therefore much the same as in sea-water, whether the saline water contains as much salt as the Barking water, or as little salt as the Chelmsford water.

The Barking water was especially selected, because there is no doubt that tidal water is entering the Chalk there. From Grays to London, tidal water is getting into the Chalk at divers places, and frequently in such quantities as to render the water derived therefrom useless for manufacturing or domestic purposes. A further proof is the effect of pumping. The lower the water is reduced, the more and more closely does the water pumped resemble the tidal water of the Thames in composition.

Moreover, cases are recorded of the rise and fall of the water-levels under tidal influence, as for example at Thames Haven, where the water in the bored well rises and falls with the tide: this is confirmed by the note in connection with this well in Whitaker's 'Geology of London.' Evidently in this locality there is some connection between the Chalk and the river.

TABLE 7.

CHALK WATERS—In parts per 100,000.

	1 Barking Town.	2 Barking Creek, well at.	3 Barking Creek, well at.	4 Thames water. Grays.	5 Grays. Heavy pumping. Chalk	6 Grays. No pumping. well.
Calcium-Carbonate ...	5·3	28·2	29·8	16·3	25·	17·1
Calcium-Sulphate ...	—	2·5	—	71·4	28·4	4·8
Calcium-Chloride ...	—	—	—	—	—	—
Magnesium-Carbonate	1·4	—	—	—	—	—
Magnesium-Sulphate	—	7·4	13·1	129·5	8·8	1·6
Magnesium-Chloride	—	18·6	9·9	154·8	24·6	1·7
Sodium-Carbonate ...	14·9	—	—	—	—	—
Sodium-Sulphate ...	9·9	—	—	—	—	—
Sodium-Chloride ...	7·	112·5	75·9	1411·6	140·4	2·6
Sodium-Nitrate ...	—	—	—	—	—	—
Silica, etc.	·5	·8	1·3	70·4	15·8	4·2
Total ...	39·	170·	130·	1854·	243·	32·
Hardness	7°	55°	50°	330°	78°	24°

The Barking waters are very interesting (Table 7). Away from the river (1) they resemble the Chalk-water of the Lee Valley partially altered by filtration through Thanet Sand, but near the river they consist of a mixture of this chalk-derived water and river-water. Nos. 4 to 6 show the effect of the Thames water on the Grays wells when heavily pumped.

Table 8 shows the saline constituents of typical waters derived from deep wells in London. It will be observed that most of these waters are of the alkaline type, but that the proportions of the constituents vary. Nearly all indicate the admixture of a very small amount of sea-water with the Chalk-water prior to it having undergone the softening process. Others derived from the Chalk near the river show the presence of unchanged tidal water, as at Millwall.

Table 9 shows that so far away as Herne Bay the Lower London Tertiaries yield an alkaline water containing much sodium-carbonate and sulphate, and other analyses on this Table and on Tables 10 and 11 show that similar waters are obtainable from the

TABLE 8.

London Chalk Waters—In parts per 100,000.

	E.C.	Caledonian Road.	Clements Inn.	King's Cross.	Charing Cross.	Millwall.
Calcium-Carbonate ...	4·4	4·	4·4	3·4	4·	27·6
Calcium-Sulphate ...	—	—	—	—	—	21·5
Calcium-Chloride ...	—	—	—	—	—	46·8
Magnesium-Carbonate	3·5	2·8	2·3	1·9	2·5	—
Magnesium-Sulphate	—	—	—	—	—	—
Magnesium-Chloride	—	—	—	—	—	15·2
Sodium-Carbonate ...	18·	19·1	21·4	21·8	18·4	—
Sodium-Sulphate ...	20·1	20·	23·2	21·9	24·8	—
Sodium-Chloride ...	16·	16·7	23·6	17·9	30·3	182·7
Sodium-Nitrate ...	·3	·6	·2	·3	·3	·2
Silica, etc.	1·	·4	·4	·5	1·2	·2
Total ...	63·	63·6	75·5	67·7	81·5	293·8
Hardness	9°	7°	8°	6°	7°	100°

TABLE 9.

Various Sources—In parts per 100,000.

	Chalk. Herne Bay.	Hastings Beds. Hadlow, Kent.	Barton Beds. Cowes.	Challow, Berkshire. Beneath Gault and Kimeridge Clay.		Swindon. Middle Oolite.
Calcium-Carbonate ...	3·4	·4	14·7	6·2	·3	31·3
Calcium-Sulphate ...	—	—	—	—	—	—
Calcium-Chloride ...	—	—	—	—	—	—
Magnesium-Carbonate	3·5	·2	3·7	2·6	·2	3·5
Magnesium-Sulphate	—	—	—	—	—	—
Magnesium-Chloride	—	—	—	—	—	—
Sodium-Carbonate ...	23·	65·2	1·4	41·4	73·9	14·
Sodium-Sulphate ...	41·7	—	5·6	8·6	—	48·3
Sodium-Chloride ...	36·3	24·9	3·3	47·	68·8	11·2
Sodium-nitrate ...	·2	·3	·4	·4	·4	·5
Potasium-Chloride ...	5·6	—	—	5·6	8·4	K_2SO_4 14·4
Silica, etc.	·3	2·	·4	2·7	2·	4·3
Total ...	114·	93·	29·2	114·5	154·	127·5
Hardness	8°	1°	19°	10°	1°	35°

most diverse geological formations. The examples given include waters from the Barton Sand, Upper Greensand, Hastings Sands, Upper and Middle Oolites (and Lincolnshire Limestone), New Red Sandstone, Coal Measures, Millstone Grit and Porphyrite, and Table 11 gives two examples of similar waters from Denmark and Damaraland. In fact these alkaline waters appear to occur in all parts of the world.

TABLE 10.

VARIOUS SOURCES—In parts of 100,000.

	Ashdown Sands. Tunbridge Wells.	Skegness. Lower Greensand.	Kelso, N.B. Porphyrite.	New Red Sandstone, Warrington.	Millstone Grit. Lancaster.	Millstone Grit. Hallam.
Calcium-Carbonate ...	2·25	2·6	1·3	8·7	14·	3·
Calcium-Sulphate ...	—	—	—	—	—	$BaCO_3$ 1·
Calcium-Chloride ...	—	—	—	—	—	—
Magnesium-Carbonate	1·05	·7	·2	4·7	1·1	7·
Magnesium-Sulphate	—	—	—	—	—	—
Magnesium-Chloride	—	—	—	—	—	—
Sodium-Carbonate ...	12·	27·6	25·2	3·	1·8	13·6
Sodium-Sulphate ...	5·2	4·	2·	3·1	2·8	—
Sodium-Chloride ...	5·	4·	3·4	3·	3·8	10·5
Sodium-Nitrate ...	·3	—	·4	1·	·2	·2
Silica, etc.	·2	·6	2·	·7	1·8	·7
Total ...	26·	39·5	34·5	24·2	25·5	36·
Hardness	4°	3½°	2°	14°	16°	13°

TABLE 11.

VARIOUS SOURCES—In parts of 100,000.

	Coal Measures.			Lincolnshire Limestone.		Damaraland. Micaceous Clay.	Denmark. Sands on Chalk.
	Rochdale.	Wolverhampton.	Oldham.	W. of Peterboro.	Peterboro.		
Calcium-Carbonate ...	6·8	38·	7·5	20·2	2·8	44·5	13·5
Calcium-Sulphate ...	—	—	—	—	—	—	—
Calcium-Chloride ...	—	—	—	—	—	—	—
Magnesium-Carbonate	5·5	12·3	3·7	3·5	·9	38·4	1·
Magnesium-Sulphate	—	—	—	—	—	—	—
Magnesium-Chloride	—	—	—	—	—	—	—
Sodium-Carbonate ...	7·6	9·4	9·7	5·1	55·5	9·7	19·
Sodium-Sulphate ...	5·9	79·9	6·5	10·3	13·2	9·1	·3
Sodium-Chloride ...	3·	17·5	2·	8·9	65·5	5·3	5·1
Sodium-Nitrate ...	2·1	—	1·	·4	·3	—	—
Potassium-Sulphate ...	—	—	—	—	4·6	—	—
Silica, etc.	·7	·9	1·1	2·5	1·2	3·	1·1
Total ...	31·6	158·	31·5	50·9	144·	110·	40·
Hardness	14°	53°	12°	26°	4°	90°	15°

The question of the sources of the sodium-salts is a problem at which I have been working for the last 20 years, and which has

caused me to try numberless experiments. In 1911, when referring to Bischof's 'Chemical and Physical Geology,' a passage was found, stating that a calcareous water passing through certain silicates of alumina containing potash and soda became softened, and directly afterwards a German process of softening water by filtration through an artificial Zeolite, and the revivifying of the zeolite by treating it with brine was brought to my notice. An experiment with powdered soda-glass was tried, and it was found that after soaking it in brine a slight softening effect resulted. Certain granites were obtained which, without soaking in brine, had a marked softening effect, and when this power was lost it could be restored by treatment with salt. The experiments are in series commencing with granite. Each experiment quoted is merely typical of many others, which, as they simply confirmed the results given, do not require further mention. The results obtained with Mountsorrel granite were as follows:—

Experiment 1. Half a kilogram of granite-dust was packed in a percolator and tap-water of 17° of hardness passed through. The hardness was not appreciably affected.

Experiment 2. Packed about 1 kilo. of coarse granite-dust in the percolator and passed through water of 57° of hardness. The first 600 c.c. which passed through was very turbid. I collected successive 200 c.c. and estimated the hardness with the following results:—4th 200 c.c., hardness 19°; 5th 200 c.c., hardness 22½°; 6th 200 c.c., hardness 28°; 7th 200 c.c., hardness 30°. Water ceased to pass through.

Experiment 3. I now added a little dilute hydrochloric acid to the granite and stirred it up; water then passed slowly again. After the acidity had disappeared water with 40° hardness was passed through and came out with only 2°, but the hardness rapidly increased and the water passed through very slowly. I then mixed the granite-dust with brine. After soaking a few hours the water passed fairly freely. Tap-water was passed through in successive half litres, and after the turbid point had been passed, to which I shall refer later, the hardness was estimated.

Original hardness of water 17°

Hardness of successive half litres—5°, 0, 0, 0, 0, 1°, 2½°, 5°, 5°, 5°, 5°.

Water of 40° hardness was now substituted. Results with successive half litres—5°, 7°, 11°, 14°, 31°, 31°, 33°. The water ceased to pass, and the experiment was therefore stopped.

Experiment 4. The granite was again soaked in brine, and it was found that the softening action was restored.

Different kinds of granite-chippings and dust from the same quarries were tried with similar results, but the finer the material used the more marked was the reaction obtained. A whiter granite has been since tried, but its softening effect was found to be comparatively slight.

The turbidity to which I referred above is due to the formation of a 'sol' or colloidal solution. It commences when nearly all the brine has passed through. The brine-solution passes in a bright and colourless condition, and contains a good deal of lime and some magnesia in solution. Upon adding distilled water, until nearly all the brine has been washed through, the filtrate becomes very red and turbid. With the addition of more water the turbidity disappears, and if hard water is now passed through it comes out quite clear and softened.

About this time a boring was being made at Broomfield, and when the Thanet Sand was reached I obtained some of it, but water would not pass through it when it was packed in a percolator. When shaken in water of 17° of hardness and filtered, the hardness of the water was reduced about 2°. Later, when pumping was in operation, a good deal of clean sand was brought up and deposited in the tank receiving the water. The following experiment was tried with this washed sand.

Experiment 5. Packed about 200 grams of the Broomfield sand in a cylinder and passed through it water of 57° hardness, collecting successive 100 c.c. Results:—54°, 20°, 8°, 7°, 11°, 16°. The sand was now so compact that more water would not pass through it.

Note.—Some expansion takes place in these experiments as on three occasions experiments were stopped on account of the glass cylinders becoming fractured.

Obviously the sand had a softening effect.

Experiment 6. More of the sand was collected and washed with tap-water to remove the clayey matter, and when put in a percolator it reduced the tap-water 2° in hardness. It was then soaked in brine and washed with distilled water. About 200 grams used.

Towards the end of the washing the liquid passing through the percolator became turbid and very similar to the turbid water which passed through the granite at the same stage. When this turbidity was disappearing water of 60° hardness was passed through and successive 100 c.c. collected and examined. The results were 4°, 8½°, 9°, 10°, 11°, 10°, 8½°, 12°, 17°, 20°, 20°.

Experiment 7. Took a kilogram of the washed sand, treated it with brine and passed tap-water of 17° through in successive 200 c.c. Results:—In the first five batches the hardness was 1° to 1·5°. Water of 60° was now passed through. The first 15 batches had a hardness of 1·5°, the 16th and 17th of 2°. As all the hard water was used up, tap-water was used again. With 14 successive 200 c.c. the hardness increased to 11° and the 15th batch passed through unchanged. Altogether 7 litres of water were passed through.

Experiment 8. The sand was again treated with brine and the tap-water passed through. The first three litres were completely softened, then the hardness increased gradually to 12° at the 14th litre. The 15th litre passed through unchanged.

The average hardness of the 14 litres was 5½°. One kilogram of sand therefore had removed lime (and magnesia) equivalent to 1·61 grams of Calcium-Carbonate. As will be seen later, the sand can remove more than this if a harder water is passed through.

Experiment 9. The sand was next treated with acid, when it was found capable of removing more lime-salt, but not nearly so much as when treated with brine. The acid and brine treatments were repeated and the sand again salted and its lime-removing power tested. The total lime and magnesia removed corresponded to 2·09 grams of calcium-carbonate, indicating that the treatment which the sand had undergone had, if anything, increased its activity.

Experiment 10. At the end of the above experiment more water of 57° was passed through with the following extraordinary result. Successive half-litres:—Hardness 70°, 70°, 90°. Showing that the sand was now giving up lime-salts.

Unfortunately at this point my experiments had to be abandoned for a time, and the sand was inadvertently thrown away. Attempts to get a similar result again have so far failed.

Experiment 11. From Heybridge I was able to obtain some sand which was brought up by the pumps employed to try and clear a bored well. This sand allowed water to pass through freely and did not require washing. Through about ½ a kilogram, a water of 20° of hardness was passed, and the successive 100 c.c.'s collected gave 2°, 2°, 2°, 2°, 2°, 4½°, 8°, 16°, 20° respectively.

Similar results were obtained with a sand from the new boring at Galleywood (see pp. 121, 122), but the sand had to be washed repeatedly with distilled water to remove the clayey matter, before it would permit of water being filtered through it.

Thanet Sand from several other places has been examined and in all cases it has exhibited the same power of softening water to some extent after washing, and to a marked extent after salting. Some sand obtained for me from the outcrop close to Erith, by Mr. G. Barrow, was found to contain a considerable quantity of lime-salts, chiefly sulphate, and when water was passed through it, it increased the hardness enormously. After washing and salting it acted like the sand from deeper sources.

EXPERIMENT 12. Thanet Sand from a boring at Dedham contained much coarser quartz-granules, but it would not let water pass through until the clayey matter had been washed away. When washed and salted it proved as active as any other sand examined. The amount of lime and magnesia removed corresponded to about 2 grams per kilogram of the sand.

EXPERIMENT 13. Through some salted sand from Thundersley, a mixture of sea-water and Halstead Chalk-water was passed. The Calcium and Magnesium in the mixed water before and after treatment were estimated with the following results:—

	Calcium.	Magnesium.	Hardness per 100 cc.
Untreated ...	9·75 mlgr. ...	2·8 mlgr. ...	33
Treated ...	1·5 ,, ...	·1 ,, ...	5

These results indicate that magnesia-salts are more readily removed than calcium-salts.

EXPERIMENT 14. Some natural water containing both salts being on hand a quantity was passed through the same filter with the following results:—

	Calcium.	Magnesium.	Hardness.
Untreated ...	6·75 ...	3·65 ...	34
Treated ...	4·4 ...	·75 ...	14

Again showing that a larger proportion of the magnesia-salts was removed. This however does not appear always to be the case.

Recently I obtained a good quantity of Thanet Sand from Dagenham (boring of the South Essex Water Co.) with which I made the following experiments:—

EXPERIMENT 15. Washed about 20 grams of the original sand with distilled water until the hardness was only 4°; then agitated it with 100 c.c. of a water of 44° and syphoned off the water. The hardness had been reduced to 20°. Shaken with another 100 c.c. of the hard water the hardness was reduced to 28°.

EXPERIMENT 16. A quantity of the sand was washed with tap-water, then mixed with brine about the strength of sea-water and left exposed to the air for 2 or 3 days. The sand was then washed with distilled water, dried, and half a kilo. placed in percolator and water of 130° hardness passed through. Successive 100 c.c. were collected. The hardness was decreased to 3° but rose to 130° at the 10th 100 c.c.'s. The amount of lime and magnesia removed calculated as calcium-carbonate was ·744 grams or 1·5 grams per kilo. of sand, or ·15 per cent.

The sand before the hard water was passed through yielded 4·83 per cent. of the chlorides of sodium and of potassium, and after the hard water had been passed through it yielded 4·61 per cent., a loss of ·21 per cent. The amount of mixed chlorides represented by the ·15 per cent. of lime-salts removed is ·208 per cent.

It is obvious, therefore, that only a small fraction of the salts of sodium and of potassium present in the sand takes part in this reaction.

EXPERIMENT 17. The half kilo. of sand used in Experiment 16 was now salted with saturated brine, washed, etc. This time the washing water did not become turbid, but merely acquired a brown colour. Some calcium-chloride was added to a very hard water and passed through the sand until no effect was produced on the hardness. Analyses gave the following results:—

	Calcium.	Magnesium.	Hardness.
Untreated ...	48· ...	2·4 ...	126 per 100,000 parts.
Treated ...	19·1 ...	1·4 ...	52 ,, ,,

As the amount of water passed through the sand was 2,000 c.c., this half kilo. had removed 28·9 mlgr. Calcium and 1·0 mlgr. Magnesium per 100 c.c., equivalent to 1·52 grams of Calcium-Carbonate from the whole of the two litres of water, or 3·04 grams per kilo. of sand. Soaking with strong brine therefore had rendered the sand more efficient than soakage in brine of the strength of the sea-water.

EXPERIMENT 18. The sand used in Experiment 17 was now washed with slightly dilute hydrochloric acid, then with distilled water and again salted. Hard water was passed through until it ceased to be affected. The reduction

in hardness corresponded to the removal of 1·44 grams of calcium-carbonate or 2·88 grams per kilo. of sand. The untreated sand only removed 3·04 grams so that the matter removed by dilute acid had no appreciable effect upon the softening.

EXPERIMENT 19. The sand used above was soaked in strong hydrochloric acid, then washed, salted and washed free from salt. Upon passing hard water through it, the softening effect was very slight. The strong acid appeared to have removed the constituent to which the softening is due. The experiment has not been repeated or the result confirmed by using sand from other sources.

EXPERIMENT 20. Some of the sand from Dagenham was lixiviated and divided into two portions, one the comparatively coarse sand and the other the finer portion which would just permit of percolation of water through it. Equal quantities were treated with brine, washed with distilled water and then treated with successive 200 c.c. of hard water. The results were:— Coarse sand, Calcium and Magnesium removed per kilo. of sand, 3 grams as calcium-carbonate; fine sand, 2·74 grams as calcium-carbonate.

EXPERIMENT 21. Half a kilo. of Thanet Sand unwashed, from Galleywood boring, softened 600 c.c. of water from 16° to 4°. It then became so compact that more water could not be passed through it. After washing and salting 1 kilo. removed the equivalent of 4·08 grams of calcium-carbonate.

So far the results of my experiments indicate :—

1. That the Thanet Sand from beneath the London Clay, possesses the power of softening hard water, by substituting salts of sodium (and possibly of potassium) for those of calcium and of magnesium.
2. That the constituent to which this softening effect is due is not removed by treatment of the sand with dilute acid, but appears to be removed by treatment with strong hydrochloric acid.
3. That this property of softening water belongs both to the clayey and sandy matters.
4. That the softening effect is greatly increased by treating the sand with brine.
5. That the amount of alkali removable by this softening effect is only a small proportion of the total alkalies contained in the sand.
6. That (within certain limits) a sand which has ceased to soften a water of a certain degree of hardness, will exert a softening effect upon a water of a greater degree of hardness, and will exert a hardening effect upon a water of a softer character.

A few analyses of Thanet Sand have been made in my laboratories, and the results obtained are compared with an analysis of a sample of granite-dust supplied to me, together with the analysis, by Messrs. LAVENDER and BATEMAN.

TABLE 12.

COMPARISON OF GRANITE WITH THANET SAND—In parts per 100,000.

	Granite.	Thanet Sand (24)	Thundersley sand.
Silica	67·16	86·55	83·74
Alumina	16·19	5·34	6·69
Ferric Oxide	3·82	2·24	2·3
Lime	2·59	·85	1·78
Magnesia	1·58	·4	·68
Potash...	5·38	2·13	1·48
Soda	2·43	·77	1·29
Water	1·02	1·9	2·04 (by diff.)
	100·17	100·18	100·

A number of less complete analyses are given in Table 13.

I am not competent to compare the mineralogical constituents of granite with those of the Thanet Sand and at present I merely direct attention to the fact that they have certain properties in common, which are probably due to a common constituent. A sample of felspar (albite) has given disappointing results, and the same applies to mica. Whatever the constituent, it is certain that the alkaline carbonates and sulphates, found in the waters derived from the Chalk and Thanet Sand in the London Basin, are obtained from the sands by substitution of sodium for calcium and magnesium in the sulphates and carbonates of calcium and magnesium present in the water before it commences to percolate through the sands. The analyses submitted show that every sample of such water can be imitated by passing a Chalk-water either without admixture, or with an admixture of a small proportion of sea-water, through Thanet Sand which has retained its softening powers. If we assume, and such certainly appears to be the case, that the Thanet Sand was deposited at the bottom of the sea, it is obvious that it would acquire the power to substitute sodium and potassium for the calcium and magnesium in any Chalk-water with which it came in contact afterwards, and thus

TABLE 13.

	Potassium and Sodium expressed as Chlorides.	Per cent. soluble in dilute hydrochloric acid.	Silica soluble in Na_2CO_3 after acid treatment.	Insoluble residue.
Granite	11·5	10·2	3·4	86·4
Dagenham Sand ...	3·9	8·6	4·9	86·5
Thundersley Sand ...	4·7	7·8	2·3	89·9
Dedham Sand ...	4·2	7·1	4·4	88·5
Dedham Sand (coarse)	—	5·7	4.5	89·8
Dedham Sand (clayey)	—	14·8	3·2	82·
Thanet Sand No. 24 ...	4·8	7·2	4·5	88·3
Thanet Sand No. 140	4·5	6·8	6·	87·2
Thanet Sand No. 255	2·6	6·2	4·6	89·2

soften the water. If any salt remained in the sand this would be taken up by the water and the chlorides would be proportionately increased. In the districts in Essex and elsewhere where these alkaline waters are found there are localities where the amount of salt in the water is excessive, and most of these, but not all, are near the coast or tidal rivers, and the question may arise whether the salt now found in such waters is derived from prior evaporation of the water from the original sea or from sea-water getting into the Chalk at various places at the present time. My impression is that it is due to an actual admixture of sea-water getting into the Chalk and sands around the coast and in the estuaries of the Thames and of the Stour, and that this tidal water gets more and more diluted with true Chalk-water the further it travels from these points. Thus in the Tendring Hundred most of the waters contain a comparatively large amount of salt, whilst away from this district the salt decreases.

Toward the south of the county the chlorides are comparatively low, due to more copious admixture with water from the

Hertfordshire Chalk. In all these areas the water derived from the Chalk is practically identical with that derived from the Thanet Sand; where there is any difference the salinity increases with the depth of the boring, *e.g.*, at Layer Marney and Walton-on-the-Naze. At Chelmsford and Braintree I have been able to get waters from the two sources, and found them practically identical. At Ingatestone there was no water whatever in the Thanet Sand, but the limited amount obtained from the Chalk was a typical alkaline water. These waters contain no free carbonic acid; therefore whatever distance they may travel in the Chalk no solution of chalk occurs, hence however much of the water is pumped the fissures do not enlarge and do not yield water more freely.

Engineers persist in continuing the borings made in Central Essex into the Chalk, but there is no evidence of more water being obtained than would have been the case had the boring ended in the sands, save where the surface of the Chalk is very elevated, as around Brentwood, whereas there is evidence that some of the sand water is lost. Thus at Writtle a certain amount of water was obtained from the Thanet Sand, and when the boring pierced into the Chalk most of the water disappeared and the Chalk had to be plugged to restore the supply. At Tollesbury, where a deep bore has just been made, the water-level fell some 15 ft. when the Chalk was pierced, a sure indication of a loss of water. Experience elsewhere, which I am not at liberty to mention specifically, proves that the Chalk absorbs rather than yields water in those areas where it is covered with a large thickness of London Clay. In any case the waters have a common origin, and if the chlorides are derived from the sea they should be accompanied by bromides, and the amount should be approximately the same in proportion to the chlorides as in sea-water. In sea-water there is one part of bromine to from 274 to 378 parts of chlorine, and in the alkaline waters the proportions vary, there being for one part of bromine from 225 to 442 parts of chlorine. Considering the difficulty of making anything like an accurate estimation of the bromine these figures are sufficiently close to indicate some relationship. The difficulty of making an exact determination led me to abandon temporarily further determinations until I had worked out a process which could be relied upon. This has proved far more difficult than anticipated, and I am not yet so certain of my results as to feel justified in giving others. I suspect that in sea-water there are other compounds of bromine besides bromides, and that there are traces of iodides and iodates or both. This, however, is a chemical question upon which I shall have something to say elsewhere.

Possibly it may be asked whether the softening effect of the Thanet Sand is sufficient to account for the removal of nearly all the salts of calcium and of magnesium from the large volume of water taken from the sands. Taking Essex alone the area under which Thanet Sand exists must be about 666,000 acres, and, assuming the average thickness to be 12 ft. (a very low estimate), and that each cubic yard contains 28 gallons of water, the water held in the whole of the sand will be about 360,000,000,000 gallons. The experiments recorded indicate that each cubic yard would completely soften 10 cubic yards of a Chalk-water of 30° hardness.

The amount of water the Thanet Sand is capable of softening on this basis is therefore 21,600,000,000,000 gallons.

Essex (Administrative County) has a population of over a million, and, if liberally supplied with water, it would use 30 million gallons per day, or 10,950 million gallons per year. The amount of Thanet Sand under the county would completely soften the whole supply on the above basis for 2,000 years, and partially soften for a much longer period.

I have recently obtained sandy matter from the beds resting upon the Thanet Sand to ascertain if they have similar properties. Mr. Whitaker recognised this sand as being from the Blackheath Beds. The sand contained much clayey matter, but it undoubtedly had the same action as the sand resting upon the Chalk.

The subject is of more than local interest, as these alkaline waters appear to occur in the most diverse formations from the Volcanic to the Upper Eocene.

At Braintree and Chelmsford and in the Southend Water Company's area, opportunities have occurred of examining samples of water derived from the Thanet Sand, and samples obtained later when the borings had been carried far into the Chalk, and in these places the waters from the two sources were practically identical. When the well at Bocking was being bored for the Braintree Rural District Council samples were also obtained from the different sources, but here the amount of water yielded by the sand was very small indeed compared with that met with when the Chalk was pierced. This well is on the border-line, the Chalk here yielding a hard water containing no sodium-carbonate, whereas about two miles to the south at Braintree the Chalk yields a soft water containing sodium-carbonate. Obviously the real Chalk-water travels no further in the Chalk than Bocking, what passes beyond flowing through the Thanet Sand.

At Bocking the water-level only fell about a foot when the Chalk was reached, and whilst the sand-water was soft and alkaline, the chalk-water was hard and free from any alkaline carbonate. (*See* analyses, p. 359.)

As the Thanet Sand near its outcrop yields very little water whilst the deeper Chalk yields it freely, whereas in central Essex the sand yields water freely and the Chalk yields little or none, it is an additional proof that the Thanet Sand derives its water from the Chalk, and that the change in character is due to its passage through the sand.

ACTION OF ESSEX WATERS ON METALS.

Speaking generally, little trouble is experienced in the County from the action of water on water-mains; but in certain places the waters obtained act powerfully on metals and give rise to complaints. Medical men have notified several cases of lead-poisoning, which upon investigation, proved to be due to the local water-supply to the houses occupied by the sufferers. Such cases have occurred at Childerditch, Galleywood Common and Great Totham (all on gravel-capped hills); but marked traces of lead have been found in other waters, although no indication of poisoning had occurred amongst the consumers.

These waters were all of the same character, they were distinctly hard, but practically the whole of the hardness was of a permanent character, or in other words, they contained very little calcium- or magnesium-carbonate, and from 1·8 to 5·4 parts per 100,000 of free carbonic acid.

Two samples from Galleywood were used for certain experimental purposes, as they were most readily available, and it was found that neutralization of the free carbonic acid reduced the action on lead to an extraordinary extent, though it did not entirely prevent it. For example, the effect produced by exact neutralization of the acid with lime-water was as under, the water being tested by passage slowly through lead shot. The lead dissolved is given in grains per gallon:—

	No. 1 water. Original water containing 1·8 pts. CO_2.	No. 2 water. Original water containing 5·4 pts. CO_2.
1st 50 cubic centimetres ...	·14 ...	·28
2nd ,, ...	·35 ...	·88
3rd ,, ...	·46 ...	1·4
4th ,, ...	·7 ...	1·75
5th and subsequent 50 c.c.	·7 ...	1·75

Neutralized water in all cases gave the figure ·07.

One of the wells had placed in it a load of clean chalk, and a year afterwards the water was examined and found to be free from lead. Both wells originally had pumps with leaden suction-pipes. Iron piping was substituted in one case, but the lead piping remained in the case where chalk was introduced into the well. When the water from the chalked well was examined a sample from the second well was also taken, and found to exert as powerful a solvent action on lead as in the previous year. As the wells were only about 100 yards apart, there is no doubt that the chalk had effectually prevented the action of the water on the leaden suction-pipe.

It is worth recording also that in other cases where well-waters have acted upon iron or galvanised iron pipes the introduction of a load of chalk has effectually prevented such action.

The waters which act on zinc and iron are of a similar character to those acting on lead, and often give rise to complaints, but apparently any water will act upon galvanised iron if the service-pipe is of considerable length, and also upon iron if it is not provided with a proper bituminous coating. In only one instance have I suspected the presence of zinc to have an injurious effect upon health. Water derived from a spring at the edge of the Bagshot Beds at Ingatestone was conveyed to a mansion through about half a mile of galvanised iron pipe. After a time the occupants, and especially a child, suffered from obstinate constipation, which always ceased when the family left home. This caused the medical attendant to suspect the water-supply, and it was found on analysis to contain 3 to 4 grains of zinc-carbonate per gallon. Years afterwards it still contained nearly as much zinc, but its use for drinking purposes had been abandoned.

At Theydon Mount the public supply, which has been in use for ten years, contains from 1 to 2 grains of zinc-carbonate per

gallon, and no evidence can be got of its having any effect upon health.

When a water contains an appreciable amount of zinc-carbonate it becomes opalescent on boiling, and an iridescent scum forms on the surface of the water and often causes persons to allege that the water contains oil. In two instances I have prevented legal action being taken by discovering that the complaint was due to a misconception of the nature of this iridescent film. In the first case the consumer alleged that the water was not fit for domestic use, and in the second it was also alleged that the water was sewage-polluted. The analysts in both cases had found traces of nitrites, and in one an excessive amount of ammonia also, but they had overlooked the presence of the zinc, which was the cause of the presence of nitrites and ammonia, by its reducing action on the nitrates present in the waters. Both were hard Chalk-waters, free from zinc in the mains and contaminated by passing through long lengths of galvanised iron service-pipes.

The public water-supply to Tolleshunt Knights acts markedly on galvanised iron and upon imperfectly coated iron pipe. A small main was laid by a private owner from the trunk-main to his estate nearly 2 miles away. The water at the end of this main was always spoken of as resembling pea-soup, though upon investigation it was found that it was only slightly turbid when drawn, but that it rapidly became opaque upon exposure to the air, and slowly deposited oxide of iron on standing. Until it had become clear in this manner it could not be used for any purpose. By very frequent flushing of this main a fairly satisfactory water is rendered available. (*See* analysis, p. 412.)

Alkaline sodium-carbonate waters have a deleterious action on plants, especially in conservatories.

With reference to the action of such waters on metals the experience in Southend is interesting. MR. BILHAM, the water-works manager, informs us that his company's regulations insist upon all communication-pipes being made from pure pig-lead, and that such pipes are not affected by the water. Pipes which have been in use many years are quite unaffected. There is a slight coating inside of iron-oxide, which doubtless comes from the large mains. Wrought iron pipes become choked with iron-oxide in a few years. Galvanised iron pipe is not so quickly acted upon, but the zinc coating only retards the action for a time. For storage-cisterns slate is the best, but lead and iron cisterns are allowed. The iron cisterns must be coated with bitumen (Angus Smith's process), and the lead must not be soldered. Syphon-cisterns of iron, enamelled with porcelain, are not acted upon, but uncoated metal cisterns are corroded unless all the internal fittings are of brass or gun-metal, drawn solid tubes with no seaming or brazing except in those parts not exposed to the action of the water.

THE RAINFALL OF ESSEX.

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In preparing the map of average rainfall for Essex it was deemed desirable to take as the period for which the averages are calculated the thirty-five years 1876-1910, as a good many short records were available during the last few years. The only possible drawback is that the figures might not correspond with those for Suffolk on the north and for Kent on the south, which were calculated for the thirty-five years 1868-1902; but a comparison of the few long records which embraced the whole period 1868-1910 showed that the differences were very small, and rarely amounted to half an inch. In a region of such low and uniform rainfall as the East of England it is impossible to fix the position of the various isohyetals on the map with the precision attainable in places where there is a great range of rainfall, and the slight differences in the positions of the isohyetals on the Suffolk border are of no practical importance. The lines as drawn on the edge of the Essex map where any difference appears are to be preferred to those shown on the edges of the maps of Kent and Suffolk.

The data utilized have almost all been published in the volumes of "British Rainfall," and they are the result in a larger proportion than in most counties of individual effort. On the south-western border a few stations have been maintained by the Metropolitan Water Board and the London County Council, or the earlier bodies responsible for the water-supply and sewage of the north of London, and in the south-east the corporation of Southend has recently established an important series of rain-gauges; but the map could never have been drawn except for the private records saved from oblivion by the British Rainfall Organization, and in many cases established by the efforts of successive Directors. Trustworthy data are lacking in several areas, the most important being on the western border, where the extent of the wettest area in the county is not clearly defined; more observations in this district are very desirable.

There are many long records, no less than eleven allowing the average of the 35 years to be taken directly, while for two others an average of the same duration was obtained by computing one year's figure, and two others by computing the figures for two or three years. The number of records employed was 180, of which 129 were in the county of Essex and 5 over the borders in adjacent counties. The shorter records, numbering 165, were corrected to their probable value for 35 years by comparison with the long records running through the whole period. For this purpose the total rainfall for each year for each of fifteen selected long records was calculated as a percentage of the average of 35 years, and these were combined in three groups representing respectively the Thames Estuary, the East Coast District and the North and West. Each group, as given in Table 1, represents the variation of rainfall from year to year in the part of the county to which it refers. The three groups are combined in the fourth column,

the Thames Estuary group (on account of the small area represented by it) being given half the weight of the other two in averaging, and this gives the best index of the variations of annual rainfall over Essex. For convenience of reference it is extended backwards for six years to 1870, thus showing the fluctuations for 41 consecutive years.

The year of greatest rainfall was 1903, with an excess of 46 per cent. above the average; 1872, which was the wettest year in most parts of the British Isles, came next with an excess of 42 per cent. The driest year was 1885, with a deficiency of 25 per cent. Three years showed a deficiency of 23 per cent., 1874, 1887, which was the driest year in most parts of the British Isles, and 1898. Five years showed an excess greater than 20 per cent. of the average, all but one before 1881; and five years showed a deficiency of more than 20 per cent., all but one after 1883, but none after 1901. The driest three consecutive years were 1900-1902 with a mean deficiency of 16 per cent. The study of very long records in all parts of the world shows that the driest three years likely to occur have an average deficiency of 20 per cent. The longest run of consecutive years with rainfall above the average was eight, from 1875-1882, the mean excess having been 17 per cent. The longest run of dry years (only one of which reached the average) was also eight, from 1895 to 1902, and they showed a mean deficiency of 12 per cent. Traces of the succession of one wet year, followed by two dry years, are to be seen in the ratios; but by no means so clearly as in other parts of the British Isles. If the relation to the average is not considered, but merely the greater or less rainfall of the years, it is seen that since 1884 there has usually been one drier year with two wetter years on each side of it; but it is worth noticing that two consecutive years each with a rainfall above the average occurred in 1909, 1910 for the first time since 1891, 1892.

The ratios of the group in which a short record lies were used in correcting the mean of that short record to the long average, except in a few special cases when the ratio of a particular station was considered more appropriate. In some instances it was necessary to correct an average for the height of the rain-gauge above ground, and this was done on the assumption that the usual rule holds good, that for moderate heights above ground a rain-gauge catches one per cent. less rain for every foot of elevation above 1 ft.

The rainfall-figures so computed and corrected were plotted to the nearest half inch on a map on the scale of 2 miles to 1 inch, and at first sight they appeared somewhat confused and contradictory. On careful study, however, it was found that most of the anomalies disappeared when the configuration of the ground was taken into account. In low flat land the occurrence of even a slight elevation produces a distinct increase of the average rainfall, and bearing in mind that while the greater volume of the rain came from the south-west, there was also a very considerable rainfall with easterly winds at certain times of the year, I found it possible to draw the isohyetal lines in a way which gave full weight to the figures on which the map was based, although if the lines had been drawn without respect to configuration, they would

probably have failed to express the true distribution of rainfall. In a few instances a figure had to be ignored, but this was only done where the acceptance of the figure would have violated a well-established relationship between rainfall and configuration, so that the probability of the observations being at fault was greater than the probability of the general principle being liable to exception at this point.

The range of rainfall was from just under 20 in. to 30 in., the higher figure being reported only at one point. By using, as in the other rainfall-maps of this series, intervals of $2\frac{1}{2}$ in. of rain, isohyetals could be drawn at 20, $22\frac{1}{2}$, 25 and $27\frac{1}{2}$ in. The general rainfall of the county was calculated in the usual way by measuring the area between successive isohyetals, multiplying by the general rainfall of the zone, adding the various products together and dividing by the total area.

The following table gives the areas of the various zones of average annual rainfall in Essex:—

Zone.	Area, sq. miles.	Percentage of total area.	General rainfall of zone.
Below 20 inches ...	38	2·5	19·7 in.
20 to 22·5 ,, ...	397	26·	21·7 in.
22·5 to 25 ,, ...	805	53·	23·7 in.
25 to 27·5 ,, ...	275	18·	25·8 in.
Above 27·5 ,, ...	7	0·5	28· in.
Total	1,522	100.	

This corresponds to a general rainfall of 23·5 in. for the whole county of Essex. Applying to this figure the percentages of the extreme years, as given in Table 1, we have for the 35 years 1876-1910:—

1876–1910.	Average General Rainfall of Essex ...	23·5 inches.
1903.	Maximum General Rainfall of Essex...	34·3 ,,
1885.	Minimum General Rainfall of Essex ...	17·6 ,,
1900–1902.	Driest 3 years Mean General Rainfall of Essex	19·75 ,,

The distribution of rainfall in Essex is very simple. Along the coast of the Thames estuary to Shoeburyness and north-eastward along the coast to the mouth of the Blackwater the line of 20 in. of rainfall runs close to the shore-line, probably never more than three miles inland. Less than 20 in. probably falls on Foulness Island and perhaps a strip of the Southminster marshes; but all land more than 10 ft. above sea-level has a greater rainfall. The chain of low elevations parallel to the coast and rising from a plain not more than 30 ft. above sea-level to a height of at least 100 ft. is marked by four rings of the 22·5 in. isohyetal. These patches of higher rainfall on the slight eminences of the coastal plain are respectively near Rayleigh, Canewdon, Southminster and Fingringhoe; a similar patch of the higher rainfall probably occurs on Mersea. It is not impossible that some of these detached areas of higher rainfall may really be prolongations of the wetter district farther inland; but we are inclined to think that they are all really separated by distinctly lower rainfall.

The isohyetal of 22·5 in. bounding the rainier or inland portion of Essex runs roughly parallel to the 20-in. isohyetal at an average

distance of about 5 miles along the south coast and 10 miles along the east coast. Speaking very generally we may say that the rainfall is probably more than 22·5 in. on all land more than 100 ft. above sea-level, and in most parts of the map east of the Lee valley it would not introduce much error if the line were drawn along the 100 ft. contour-line.

Rainfall exceeding 25 in. occurs over only a small part of the area of Essex, being confined to the highest land in the west; it does not appear to occur farther east than Ingatestone and Brentwood. The valely of the Lea as far north as Feilde's Weir has less than 25 in. of rain, though this holds good only on a narrow strip, probably nowhere much exceeding one mile in width on the Essex side of the border. The valley of the Roding also carries a narrow strip with a rainfall under 25 in. separating two wetter areas. Of these the eastern has a rainfall very little exceeding 25 in. in any part, but its bounding isohyetal extends roughly parallel to that of 22·5 in. on the south and east outlining an irregularly triangular area about 10 miles in the side. The land included is for the most part more than 250 ft. above the sea.

The higher ridges between the Lea and Roding valleys south of Harlow, extending from north-east to south-west for 15 miles, and narrowing from 9 miles in width on the north to a mere point in the south, include the highest rainfall of Essex. The 25-in. isohyetal surrounds this area running at an elevation of about 150 ft. in the south to something over 250 ft. in the north, while the highest ridge, on which Epping Forest stands, appears to have a rainfall exceeding 27·5 in. at elevations above 350 ft., even if we do not accept the full value of 30 in. given at one station near Epping.

In the north-west of the county the rainfall also exceeds 25 in., though in the extreme north-west, near Great Chesterford, it begins to diminish again. The 25 in. isohyetal runs approximately from near Bishops Stortford north-eastward to near Sudbury, more or less along the contour-line of 300 ft., which may be taken as marking the south-eastern edge of the highest part of the East Anglian Ridge, and along this ridge it continues into Suffolk. This is the part of the county in which observing stations are fewest, and some of the records which exist are not very satisfactory, so that it is impossible to say whether the highest part of Essex receives a rainfall high enough to give occasion for a 27·5 in. isohyetal where the elevation rises above 400 ft.

The rising in the level of all the isohyetals towards the north-east shows, as in the case of Hampshire and Sussex, the power of the south-westerly winds as rain-carriers, a greater elevation being necessary to reduce the temperature of the residual water-vapour to the saturation-point as the absolute humidity is reduced by the formation of rain.

Table 2 gives the total annual rainfall at a number of stations selected at nearly equidistant intervals, so as to represent all the zones of rainfall. The data given are the height of the receiving surface of the rain-gauge above the ground, the height of the station above sea-level, the period during which the observations were carried on, the length of the record, the group in Table 1

by the ratios of which the reduction to a period of 35 years was made, the computed average and the computed average corrected for height above ground in the cases where this was necessary.

Table 3 gives the average and extreme monthly rainfall at four representative stations. The wettest month at the two eastern stations was October, 1880, when at Shoeburyness the extraordinary amount of 8·21 in. was recorded. At the two western stations the wettest month was September, 1896, when 7·72 in. fell at Epping. The driest month was February, 1891, when no rain was registered at Chelmsford and Epping, and only ·02 in. at Newport, and ·06 in. at Shoeburyness. At the last-named stations April, 1893, was rather drier with ·02 in. For convenient comparison of the proportion of the year's fall in each month, the average rainfall is also expressed as a percentage of the annual total. The mean of the percentages at the four stations gives the best possible statement of the seasonal distribution of rainfall. The six months, January to June, show a mean value of 7·1 per cent. of the annual fall per month, the six months July to December a mean value of 9·5 per cent., showing that the first half of the year is distinctly drier than the second half. The driest month is April, with 6·5 per cent. of the year's rain, but the four months January-April are almost equally dry. From April there is a rapid increase in the amount of rain month by month to August, which has 9·7 per cent., a sudden fall in September to 8·1 per cent., and a maximum of 11 per cent. in October which, as in most parts of England, is the wettest month of the year. The falling off thence to January is more rapid than the rise from April to August. The type of seasonal distribution of rain in Essex is that of the double maximum in August and October common to the eastern counties, and in the relation of the August to the October maximum it is intermediate between the type prevalent in Lincolnshire, where they are nearly equal, and that in Kent and Sussex, where the August maximum is so much lower as to be inconspicuous.

TABLE 1.

Essex Rainfall. Average = 100.

Year.	A Thames Estuary.	B East Coast.	C North and West.	Mean for Essex.
1870	84	80	78	80
1871	103	97	95	97
1872	154	147	131	142
1873	99	94	92	94
1874	75	75	81	77
1875	116	119	113	116
1876	116	115	110	113
1877	123	125	120	122
1878	123	102	113	111
1879	128	124	130	127
1880	128	121	117	121
1881	105	104	110	107
1882	113	119	114	116
1883	94	95	103	98
1884	76	76	75	75
1885	102	106	110	107
1886	99	94	100	97
1887	77	77	77	77
1888	119	108	109	111
1889	107	107	104	106
1890	98	100	94	97
1891	101	96	108	102
1892	101	113	100	105
1893	78	82	80	80
1894	111	105	102	105
1895	84	84	83	84
1896	99	101	102	101
1897	90	92	95	93
1898	71	81	77	77
1899	92	100	97	97
1900	89	91	93	91
1901	77	75	83	79
1902	80	86	81	83
1903	149	145	145	146
1904	84	82	83	83
1905	84	79	86	83
1906	99	105	102	102
1907	92	92	91	92
1908	93	88	91	90
1909	114	125	113	118
1910	104	105	102	104
Average 1876—1910	100	100	100	100

TABLE 2.

Average Annual Rainfall of Essex.

Stations.	Height above Ground.	Height above Sea level.	Period of observation.	Number of years.	Arithmetical mean.	Group in Table 1.	Computed average for 35 years.	Computed average corrected for height above ground.
	Ft. In.	Ft.						
Shoeburyness	4 7 7 0 2 0 1 0	13	1876—1910	35	19·23	—	19·2	19·9
Orsett	3 0	73	1894—1908	15	20·47	A	22·0	22·5
Barking Cemetery	1 0	18	1894—1910	17	21·90	A	23·1	23·1
Walthamstow, Ferry Lane ...	1 0	30	1895—1910	16	22·46	A	23·9	23·9
Havering-atte-Bower	1 0	—	1891—1905	15	21·86	C	23·2	23·2
Sawyers Hall Farm...	1 0	270	1876—1899	24	25·22	C	24·9	24·9
Wickford, Runwell Hall	1 0	75	1895—1910	16	23·18	B	24·2	24·2
Cold Norton, Norton Hall ...	2 6	130	1876—1893	18	22·82	B	22·0	22·4
Foulness	1 2	9	1895—1909	15	18·86	B	19·8	19·8
Bradwell-on-Sea, Down Hall ...	1 0	20	1877—1899 1902—1904	26	21·99	B	21·8	21·8
Chelmsford	1 0	92	1876—1910	35	22·92	—	22·9	22·9
Epping	0 8	345	1876—1910	35	29·92	—	29·9	29·9
Sheering Rectory	1 0	214	1876—1898	23	24·59	C	24·2	24·2
Witham, Little Braxted Hall ...	1 0	50	1882—1905	24	22·27	B	23·3	23·3
Layer Breton Rectory	1 0	88	1894, 1900—1904	6	20·98	B	21·6	21·6
Fingringhoe, Ballast Quay Farm ...	2 0	47	1895—1910	16	21·26	B	22·2	22·4
Great Clacton, Clay Hall	2 0	40	1898—1909	12	20·23	B	21·1	21·3
Ramsey, Hill House	0 6	80	1892—1910	19	23·93	B	24·8	24·8
Dedham Dalethorpe	1 1	54	1899—1910	12	21·93	B	22·4	22·4
Earls Colne	1 0	188	1878—1910	33	23·10	B	23·4	23·4
Braintree, Bocking Fennes ...	2 6 1 3	240	1876—1887 1890—1910	33	23·29	C	23·4	23·5
Dunmow, New Street	1 6	245	1880—1885	6	25·21	C	24·1	24·1
Newport	4 0	208	1877—1910	34	24·76	C	24·8	25·6
Bulmer Lodge [Sudbury]	1 3	200	1890—1910	21	24·46	C	25·6	25·6

TABLE 3.

MONTHLY RAINFALL—ESSEX, 1876–1910.

Months.	Shoeburyness. Mean monthly fall.	Wettest month.	Year.	Driest month.	Year.	Chelmsford. Mean monthly fall.	Wettest month.	Year.	Driest month.	Year.	Epping. Mean monthly fall.	Wettest month.	Year.	Driest month.	Year.
	In.	In.		In.		In.	In.		In.		In.	In.		In.	
January	1·31	4·50	1877	·14	1880	1·52	4·49	1877	·15	1880	1·99	4·77	1877	·46	1880
February	1·23	2·84	1900	·06	1891	1·53	3·14	1900	·00	1891	2·04	4·29	1883	·00	1891
March	1·21	2·65	1897	·20	1880	1·66	3·49	1897	·30	1893	2·07	4·44	1888	·52	1893
April	1·24	2·29	1877	·02	1893	1·42	2·95	1879	·08	1893	2·00	3·98	1879	·15	1893
May	1·34	3·96	1878	·05	1881	1·56	4·32	1878	·17	1896	2·15	5·03	1886	·48	1895
June	1·78	6·15	1903	·14	1886	1·98	5·70	1903	·25	1886	2·61	6·96	1903	·34	1886
July	1·65	4·80	1903	·24	1885 / 1905	2·24	5·82	1903	·48	1885	2·84	6·28	1888 / 1903	·53	1876
August	1·76	4·33	1878	·32	1883	2·32	5·12	1878	·50	1880	2·88	5·40	1878	·62	1899
September	1·66	5·20	1885	·31	1898	1·84	5·23	1896	·30	1898	2·42	7·72	1896	·38	1898
October	2·27	8·21	1880	·19	1897	2·49	6·26	1880	·67	1897	3·25	7·67	1882	·75	1897
November	2·04	3·82	1888	·41	1901	2·26	3·90	1906	·70	1901	2·94	6·56	1888	·65	1901
December	1·74	7·16	1876	·43	1905	2·10	5·51	1876	·60	1885	2·73	7·46	1876	·58	1905
Year ...	19·23	29·52	1903	12·59	1901	22·92	33·75	1903	16·99	1887	29·92	40·80	1903	20·27	1904

TABLE 3—continued.

Months.	Newport.					Mean monthly fall expressed as percentage of annual average.					
	Mean monthly fall.	Wettest month.	Year.	Driest month.	Year.	Shoebury-ness.	Chelmsford.	Epping.	Newport.	Mean.	Months.
	In.	In.		In.							
January	1·73	3·97	1877	·17	1880	6·8	6·6	6·7	7·0	6·8	January.
February	1·71	5·53	1900	·02	1891	6·4	6·7	6·8	6·9	6·7	February.
March	1·80	3·77	1888	·32	1893	6·3	7·2	6·9	7·2	6·9	March.
April	1·68	3·63	1908	·17	1893	6·4	6·2	6·7	6·8	6·5	April.
May	1·90	3·75	1878	·31	1896	7·0	6·8	7·2	7·7	7·2	May.
June	2·09	5·71	1903	·41	1887	9·3	8·7	8·7	8·4	8·8	June.
July	2·44	5·32	1891	·34	1878	8·6	9·8	9·5	9·8	9·4	July.
August	2·42	4·64	1881	·91	1906	9·2	10·1	9·7	9·7	9·7	August.
September	1·93	6·05	1896	·20	1898	8·6	8·0	8·1	7·8	8·1	September.
October	2·60	5·30	1885	·64	1879	11·8	10·8	10·8	10·4	11·0	October.
November	2·34	5·36	1878	·69	1909	10·6	9·9	9·8	9·4	9·9	November.
December	2·21	5·10	1876	·49	1879	9·0	9·2	9·1	8·9	9·0	December.
Year	24·85	33·68	1903	16·4	1884	100·	100·	100·	100·	100·	Year.

SPRINGS, ETC.

Essex is not a county that abounds in powerful springs, as do Hampshire, Kent, Surrey, and Sussex, in the Memoirs on which many pages are devoted to this and kindred subjects. Those counties not only have a large tract of more or less bare Chalk, but also a considerable outcrop of Lower Greensand, the two chief water-bearing formations of South-eastern England. Essex, on the other hand, has no outcrop of any bed below the Chalk, and its area of bare Chalk is comparatively small. Most of its springs are small, and derived from comparatively thin surface-deposits, of a permeable kind; and of these springs there are many.

Springs that are used for supply are noticed further on, under the heading Spring Supplies (pp. 73–82), and some find a place amongst mixed supplies that are chiefly from wells, as will be seen from the Index.

Chalk.

Of Chalk-springs there is little to be said. H. B. Woodward has noted[1] that "on the far northern side of the Chalk Basin there is a copious outflow beyond Heydon along the outcrop of the Totternhoe Stone"; but Heydon and the outcrop of the Lower Chalk, by a process of legal disturbance, have been thrown out of Essex into Cambridgeshire, as above noted (p. 2).

He adds that "Along the Cam valley below Newport many springs issue and there are good watercress beds"; some also at Newport. Of these springs, which contribute to a northerly flowing stream, the following details are taken from a set of privately printed papers[2] for the knowledge of which we are indebted to Mr. Woodward, notes as to sites being added from a map. The informants are Harold Warren (pp. 11, 12), and Dr. W. Armistead (p. 26).

Taking first the tributaries on the left or western side of the Cam, the Wicken Bonhunt springs, eastward of the village, are the highest permanent springs feeding that river [save in times of bourne-flow], being about 202 feet above Ordnance Datum. The disappearance of water here is noticed further on (p. 48). The level of the Newport springs, westward of the church, is 187 feet.

In another tributary-valley, a little to the north, the Wenden springs, of which there are several, westward and just south-eastward of the village, vary in level from 175 to 178 feet.

On the right, or eastern, side of the Cam, in the valley of the Debden Water, the springs, a little eastward of Newport, are 181 feet above Ordnance Datum.

Farther northward the Audley End springs, in short side-valleys, by and southward of the Abbey, vary in level from 154 to 157 feet, another spring, north-eastward of the house, being 148 feet.

The only notes of swallow-holes in Essex that have been taken were made during excursions of the Essex Field Club in 1912 and

[1] Victoria History of Essex, vol. i.

[2] Evidence in Support of Petitions against the Bills (S. Essex Water Board, S. Essex Waterworks Co.), by the Cambridgeshire County Council, 1900. This refers largely to Cambridgeshire.

1914. The first was of a small one in a ditch near Bilden End, Chrishall, and about half a mile westward of Chisewick Hall; the second was of a water-sink in a little valley 1½ miles a little north of east from Saffron Walden church. No record of any others has been seen. The conditions are unfavourable for the formation of hollows into which streams may sink.

Probably all the small Chalk-streams that flow into the Cam are more or less of the nature of bournes, that is to say, their point of origin is liable to seasonal variations, higher up the valley after times of heavy rainfall, lower down after dry times. Certainly this is the case with the Wicken Water, the stream flowing from Arkesden eastward, as I have seen it dry at Wicken Bonhunt. The same may be said of the Cam itself, which must sometimes rise a good way above the 200 feet contour.

Of the springs that often rise at or near the junction of the Tertiary beds and the Chalk in other counties Essex gives but few examples, that junction being so largely hidden by Drift on the north, whilst on the south, where it is practically free from Drift, it is but a few miles in extent. H. B. Woodward[1] has noted that "overflows . . . . escape at the surface on the margin of the Tertiary strata, as at Banfield (Bentfield) Springs near Bishops Stortford on the north, and at Grays and Purfleet on the south." Of the former, which are just north of the mill and in the parish of Stansted Mountfichet, it is elsewhere recorded that the level is 204 feet above Ordnance Datum. Some springs at the village are noticed further on, p. 67.

The following notes of a few springs in the southern area, eastward of Grays, taken in December, 1892 (by W. W.), are given as examples: there are probably many others.

A spring marked on the old six-inch Ordnance Map (Sheet 83), in the marsh about 440 yards ENE. of Little Thurrock church I could not find, it having apparently been filled up; but I saw another (not marked) in the ditch bordering the marsh a little over 1,000 yards in the same direction from the church, just SE. of the farm named Bretts, and a slight one at the head of a little ditch about 340 yards E. of S. from Chadwell Place, whilst one at the head of the next little ditch, about 80 yards eastward, had gone, or nearly so. There is another in the ditch some 25 yards westward of Hutt's House, and about 670 yards south-westward of Chadwell church. The name St. Chad's Well (nearly 600 yards southward of the church) is suggestive of a spring.

London Clay.

S. H. Warren has said, in describing an excursion near Loughton, at which I was present: "After passing under Staples Hill, evidences of a series of springs, thrown out on both sides of the valley, were observed. The level at which these springs appear is about, or rather below, the 200 feet contour, and they probably indicate the presence of some permeable bed included in the London clay."[2]

[1] Victoria History of Essex, vol. i, p. 6.

[2] *Proc. Geol. Assoc.*, 1910, vol. xxi, pt. 8, p. 452.

There are probably many other like springs, from sandy beds in the London Clay: notably, of course, sundry mineral springs.

Bagshot Beds.

Although there is no very sharp division between the Bagshot Beds and the London Clay, but more or less of a passage, yet the change from sand downward to clay, or sandy clay, is marked enough to give rise to springs, or damp ground, which indeed is often the most trustworthy sign of that change. A few instances will be given.

At the High Beech outlier, Epping Forest, there are many springs on the northern side of the Common, sometimes with a rich growth of bog-moss (*Sphagnum*), and of other marsh-plants. On the east, in the nursery southward of the King's Oak Inn, I saw, more lately, a spring, with a bog-garden.

Writing of the old fish-ponds at Warley Place, J. C. Shenstone says: "Here we find two picturesque pools fed by natural springs which rise in the hillside. They show very little diminution in the water level, even in the dryest summers."[1]

At Billericay the junction of the Bagshot Sand and the London Clay was laid open in a deep railway-cutting, which I saw in 1887, and "it was marked by wet, for though a most exceptionally long time of drought had occurred (August 1887), the quantity of water thrown out had given much trouble, entailing drainage-work."[2]

A fairly voluminous spring on the hillside NW. of Slice's Gate was opened out some years ago, to see if the flow were sufficient to supply Billericay; but it was not.

H. B. Woodward has referred to springs at the Stock outlier (see p. 57), and there are also springs at the neighbouring outlier of Galleywood, one being marked on the six-inch Ordnance Map (52, SE.), by the roadside, about 600 yards SW. of the church.

At Laindon Hill, H. W. Bristow long ago noted the outflow of water at the junction of the Bagshot Sand and the London Clay, on the eastern side of the outlier, in the road between West Lee Tye and Blackmans,[3] and at a later date Dr. A. E. Salter drew attention to springs on the northern side, at the same junction; one resulting in a stream with a small well-marked valley.[4]

I have noted springs here at the following places:—On the northern side of the road at the rectory (used for supply), at the head of the stream, near Butler's Grove, and about 900 yards NE. from the church; on the southern side of the road, half-way between Butler's Grove and Nightingales Farm; and apparently others just NE. of West Lee Hall, in the next hollow some 160 yards ENE., and in the lane about 130 yards NW. of West Lee Tye; between the last two there is a hollow, the bottom of which

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[1] *Essex Naturalist*, 1912, vol. xvii, p. 56.

[2] The Geology of London, etc. *Geol. Surv. Mem.*, 1889, p. 277.

[3] *Geol. Surv. Memoirs.* The Geology of the London Basin, 1872, p. 328. Reproduced in The Geology of London, etc., 1889, vol. ii, p. 279.

[4] *Proc. Geol. Assoc.*, 1907, vol. xx, p. 182.

is springy, as shaded on the six-inch Ordnance Map (Sheet 72), on which moreover springs are marked at Butler's Grove and at the eastern point of Hall Wood (used for supply).

Drift Gravel and Sand.

The number of springs thrown out from the permeable members of the various divisions of the Drift, by underlying clays, is legion, and one can only notice now those few of which some note has been published, or which have come before one in visiting certain districts. Such names as Springfield, Roxwell, etc., point to the presence of springs.

At High Ongar a spring about 300 yards south-west of the school, once supplied the school with water.

At Newport there are springs in rear of the Grammar School, an analysis of the water from which is given on p. 423.

In his Report to the Chelmsford Rural Sanitary Authority for 1892, Dr. Thresh said of Writtle: "At the western end of Oxney Green there are several springs yielding from 5,000 to 20,000 gallons a day each of water of great purity, though somewhat hard." The brewery-spring (between the brewery and the church) yields a considerable amount of water and was formerly used by many inhabitants.

At Great Baddow springs are marked on the six-inch Ordnance Map (Sheet 53, NW.), some 930 yards W. of N. from the church and about 700 yards eastward of the spring taken for supply (see p. 77), which is not marked on the map (52, NE.), though the bigger of the two. There is another spring a little higher up the valley than the waterworks and another at Moulsham Lodge.

Dr. Thresh has said: "At Little Baddow whilst there are numerous springs of water, they are either inconvenient of access or liable to pollution."[1] He adds (1914) that until recently several, at the edge of the Danbury gravel-patch, were used.

The following note is by H. B. Woodward: "Among the noteworthy permanent springs is one known as Cromwell's Well. at Maldon, which issues from the Glacial gravels."[2] At Heybridge springs break out at the edge of the wood, to the north; some time ago these were cleared and pumped, but they could not be depended on to yield the supply for the village.

F. J. Bennett, writes (1913) that at Bran End, Stebbing, a spring constantly yields 8 gallons a minute.

In the valley of the Brain, above Witham, I noted springs on the left side in December, 1900. In the parish of Faulkbourne one, about 800 yards NNE. from the church, and just below the 100-ft. contour-line on the map, then yielded much water; whilst another lower down the valley and a little farther below that contour-line, about 570 yards ENE. of the church, was dry at the head, and with little water just below. Lower down, in the parish of Witham, there was a spring at the riverside about 1,190 yards north-westward of Chippinghill church, and another about 100 yards eastward, just south-eastward of which the ground was of a springy nature.

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[1] Report to the Chelmsford Rural Sanitary Authority for 1893.
[2] Victoria History of Essex, vol. i, p. 22.

The Roman spring at Earl's Colne rises near Tilekilns Farm. It was once suggested that this could be used for the supply of the town.

There is also a spring on the Golf Links at White Colne.

At Coggeshall there are several springs in the valley; but none yielding enough to supply the town. (See also p. 75.)

At Ardleigh I saw springs at the back of the Railway Tavern, just north of the station, and there was springy ground along the road some 500 yards south-south-eastward from the station.

At West Mersea there is a well-known spring, called St. Peter's well, close to the shore on the south of the village. It has been suggested that it could be used for supplying the village; but the yield is too small and the risk of pollution too great. (See also pp. 305, 306.)

At St. Osyth I have noted springs at the following places: the northern end of the Kitchen Pond, in the park, and there must be others hereabout; about 760 yards eastward of the church a spring is drained into the stream, where a lane comes down to it; at the south-eastern corner of Bush Paddock, by the roadside some 1,280 yards east-north-eastward of the church there was a spring and pump.

At Dedham a spring above Lamb Inn Corner is said to yield 10,000 gallons of water a day. It was at one time suggested that the village should be supplied from this.

It is to be hoped that observers will take notes of the more prominent springs of the county, so that the above somewhat meagre account may be supplemented. The subject is one of local interest, and works in with botanic and entomologic research.

Mineral Springs.

Whilst classifying certain springs under the above heading, it must be understood that there is no marked division between mineral springs and others; it is merely a question of proportion. When a water contains more than a usual amount of dissolved mineral matter it is called a mineral water; but the difficulty is to define what is usual. In practice, when a water contains things that have any peculiar effect, medicinal or otherwise, it is looked on as medicinal water; but here again we are met by a difficulty, that of determining when a water has any medicinal efficacy, and this is a difficulty of large secular variation. We are now in an age of scepticism as regards the special efficacy of very many waters that a hundred years ago were looked on with respect, whilst now they are practically disregarded. In this, as in many other matters, classification is a matter of convenience; nature does not make marked divisions.

In this Memoir it is convenient to return somewhat to the faith of our fathers, as the subject has been well and thoroughly treated by M. Christy and Miss May Thresh,[1] whose lately published book has relieved us from going into the subject in detail; it is

[1] A History of the Mineral Waters and Medicinal Springs of Essex. *Essex Naturalist*, 1909, vol. xv., pp. 185-253. Reprinted, in book-form, 1910, with Addenda, Index, etc., pp. viii, 73. Price 2s. 6d.

enough here to show the scope of their work, by noting its contents, which are as follows:—

Introductory, pp. 1-6. Bibliography, pp. 6-10. Particulars of each spring, pp. 10-63; the springs being at Chigwell Row, Colchester, *Dovercourt, Havering, *Hockley, *Hornchurch Lane, *Ilford (St. Chad's well), *Little Dunmow (called Felstead), Little Leighs, Markshall, Plaistow, Romford (Gidea Hall), South Benfleet, *South Weald, Springfield, *Stapleford Abbots, Twinstead, *Upminster, Wanstead, *West Tilbury, Wethersfield, Witham, *Woodford, and Woodham Ferrers; with analysis of the water of those places preceded by *. Remarks from geological point of view, pp. 63, 64; and from chemical point of view, pp. 65–68.

Whilst referring those interested in the subject to the book itself, some of the conclusions may be given, in the words of the authors:—

"With few exceptions, the reputed Essex Mineral Waters which we have analysed . . . cannot be regarded as Mineral Waters at all. The few which may be rightly so classed owe such medicinal properties as they possess almost entirely to the presence in them of magnesium sulphate (Epsom salts). Waters containing this salt are in no way remarkable in Essex; for such waters are found in many parts of the county, and wells have frequently been abandoned, as sources of domestic supply, owing to the excessive amount of saline constituents present in their waters."

Of the waters examined "only three can be classed as Mineral Waters . . . those from South Weald, Upminster, and Hockley. Even these have . . . little or no medicinal value, the amount of their saline constituents being small."

Others "have no medicinal properties whatever. . . ."

"It appears, therefore, that our Essex Mineral Wells (so called) have, perhaps, obtained their reputations without being justly entitled thereto. It is conceivable, of course, that our wells, or some of them, really did possess, at one time, the properties with which they were credited, and that those properties have become, in some way, lost or exhausted. . . ."

"We think it more probable, however . . . that the waters of our Essex wells never possessed . . . any real medicinal value, and that 'faith' was an important, if not the chief, element in the 'cures' they are credited with."

At the end of the book, in a note by W. H. Dalton, it is said: "That with the exception of Tilbury, all the springs noticed are within the area of the London Clay, and their waters are derived from sandy seams in that deposit or from its contact with superficial gravels over it, the gravels in the latter case furnishing merely the water, and the mineral ingredients being derived from the clay. In no case does the Boulder-clay take any part."

These London Clay waters were, however, regarded as useful from being slightly aperient, by reason of the magnesium-sulphate they contain.

CONTAMINATION AND RISK THEREOF.

General Remarks.

It is of value to get together records of events that have happened, even many years ago, in regard to the pollution of water-supplies, or to the mere risk of such pollution, from various causes. We should be unwise in passing by such records, as mere matter of history, referring only to troubles that have ceased; for it is largely by a study of the mistakes and mischances of the past that dangers may be avoided in the future. Detailed information of this sort is largely got from the Reports of the Local Government Board; but we also get much from Reports of Medical Officers, and some from other observers.

In 1893 Dr. Thresh, in treating of wells sunk through the London Clay, said that "many of the wells, more especially the older ones, are so badly constructed that it is quite uncertain what proportion of surface or sub-soil water they contain. As the water from these superficial sources is usually, if not always, very impure, containing much organic matter and nitrates, we can invariably detect its presence, but we can only roughly estimate the quantity. According to the varying proportion of surface to subterranean water will the constituents vary on analysis. Take, for example, the water at Goldhanger Rectory and at Cold Norton Railway Station. In 1889 the water from the rectory well was uncontaminated. In 1891 there were reasons for suspecting that the water was being fouled, and upon analysis such proved to be the case. Evidently water containing less saline matter and more lime salts and nitrates (*i.e.*, impure surface water) was gaining access to the well. At Cold Norton Railway (Station) the water obtained soon after the well was bored contained so much nitrates and lime salts that I felt justified in condemning it as impure. The well was opened and some improvements made. The quality of the water also improved; but it still was impure. The well was again examined, and, I believe, some puddling done, or the brick-work cemented. The result was that when the water was again submitted to analysis it proved to be pure. At Stow Maries (Hogwell) we have not been so fortunate. When I examined the water, in 1890, I found it very impure, and I reported that sub-soil water was entering the well. The railway company had the water pumped to a low level, and something was done at the well itself . . . and at my next visit the water taken gave no indication of impurity. Recently, however, I was told that the water was again very hard, and, upon examining a sample, I found it as bad as at first."[1]

In reporting to Parliament on the South Essex Waterworks Bill, 1899, the Local Government Board made the following remarks on a proposed well at Mucking (? the taking over of the Muckingford or Linford Well, p. 226).

"The water obtained from the chalk beneath the tertiary beds in South Essex, and especially in the limits of supply of the Company, is, owing to the dip of the chalk from south to north,

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[1] *Essex Naturalist*, vol. vii, pp. 32, 33.

in all probability, largely derived from Kent, the water passing under the bed of the Thames. The chalk in South Essex, however, being denser than Kent chalk, has less capacity for holding water; hence a considerable body of water passing northwards from Kent finds vent in springs issuing in the bed of the Thames. In times of drought, and especially as pumping stations multiply in the north of Kent, the amount of water passing northwards, and consequently the amount breaking out upwards in the bed of the river, tends to become diminished. Pumping from the chalk in South Essex may be thought of as liable to further diminish, if not to arrest the upward issue of chalk water in the bed of the Thames, and even, if excessively indulged in, to reverse the springs in the Thames bed and draw Thames water downwards and northwards beneath Essex. It would appear that the water derived from the Company's present works at Grays contains more salt than heretofore, and it has been suggested that this is due to the derivation of larger proportions of it from the Thames, and the new well proposed . . . will, seemingly, bear the same relation to the water in the chalk and the Thames as do the existing Grays wells."

With regard to the above it should be noted that the Mucking site is a good deal further from the Thames than the Grays well is, and still further from where the river runs over Chalk.

"If the well at Mucking is intended only for the supply of the parishes proposed . . . to be added to the Company's limits, the moderate pumping which would be necessary . . . would not, perhaps, necessarily involve the drawing of water from the Thames; but if . . . the water from the new source is requisitioned to supplement the supply in the existing limits . . . the risk of laying the Thames under contribution may become a very real one."

Attention is then drawn to another presumed risk. "The site of that well [Mucking] is almost immediately north of Gravesend, on the opposite side of the river. [It is more than three miles NNE. of that town.] Gravesend, which is unsewered," once had many private wells in the Chalk. Now that there is a public supply "many of those wells are utilised as cesspools, and the liquid matter from them may possibly pass . . . northwards to the site of the proposed well."

These remarks were reprinted in the following year, in the Board's Report on the South Essex Water Bill, 1900. They seem to reflect somewhat on Gravesend. I am inclined to think, however that it is a far way to Mucking, and not exactly in the direction in which one would expect the underground water to flow from Gravesend, the dominant planes of jointing running roughly SE. and NW., that is away from a line from Gravesend to Mucking, which is SSW. and NNE.

Local Cases.

These are taken in chronological order except where there are two notes on the same place. Many smaller cases are referred to in the descriptions of various wells and waters, as will be found from the Index.

Terling.

In his Report on Typhoid Fever at this village Dr. [Sir] R. T. Thorne describes the general conditions of the place in 1868,[1] a description which probably held for most small villages in the district, and so is of general interest.

"In the central part of the village, each cottage, or each group of two or three [cottages], has its own well, and if the ground is at all undulating, it is invariably placed at the lowest point. These wells which are all sunk in the gravel, are as a rule uncovered, and are merely lined with bricks placed loosely one above another . . . on a higher level than these wells and everywhere surrounding them, lie the various nuisances (manure-heaps, cesspools, privies, sometimes overflowing) . . . and since the soil is of a very loose and porous nature . . . the closeness of such sources of contamination to the cottagers' drinking water is seen to be fraught with the greatest danger."

"The general tendency of the evidence . . . is to the effect that the water supply of Terling was the great infective influence," and some of the cases "also seem very definitely to connect the outbreak of disease with a particular change in the level of the surface water . . . the water in the wells had gradually sunk during the latter part of the summer and autumn. . . . Following this drought, came a sudden flow of water into all the wells," and this was just before the outbreak.

"I carefully examined every well throughout the village, and I found that with very few exceptions they were all so placed that the water they contained could easily become contaminated."

"It is evident that for years the land springs supplying the village must have washed the foul materials which had soaked through the ground into the wells, although, owing to the water being very abundant, the contaminated solution thus formed was very much diluted. Recently, however, although the soakage of filth into the ground has been going on, there has been a deficiency in the water supply (from the drought above alluded to); that filth must therefore have accumulated until the rise in the surface water took place, when the whole would naturally be washed from the surrounding ground into the wells, and thus give rise to an intensely saturated solution," and the evidence makes it clear "that immediately after an exceedingly rapid rise in the surface water, which had been preceded by an *unusually* prolonged period of drought, an epidemic of typhoid fever of very great magnitude and intensity broke out."

Sir R. Thorne examined various neighbouring places, and he says "that the sudden rise in the surface-water which seemed so clearly to bear upon the outbreak of typhoid fever in Terling, had not been noticed in any of the other portions of the Witham Union which I visited, and in which I did not find that there had been any scarcity of water during the summer and autumn of last year" (1867).

At the time when this outbreak was investigated it was not known that milk was a vehicle by which infection could be spread. At a later date Dr. Gimson told one of us that, although at the

[1] *Tenth Rep. Med. Off. Privy Council.* Pages quoted from 42, 43, 45, 50, 51, 56. I had the pleasure of helping in this investigation. W W.

time he suspected the water, he believed that the outbreak was due to infected milk.

Wicken Bonhunt.

In 1869 Dr. [Sir G.] Buchanan wrote a Report on an Epidemic of Typhoid Fever at Wicken Bonant,[1] in which he says:—"The water supply of the village is partly from the 'parish well,' used by the inhabitants of 19 houses; partly from private wells which supply the other 21 houses. The wells are sunk through a varying amount of gravel into the chalk. . . . The level of the water below the surface ranges (chiefly, it appears, according to the level of the surface where the well is situated) from 20 to 35 ft.; but of course this level would vary materially according to the wetness or dryness of the season. . . . The parish well . . . by the roadside, is four or five paces from the brook channel, and it has been observed that after heavy rains, and when the brook is flowing, the water of this well is discoloured."

In his note on the geology W. H. Penning says:—"At the upper or west end of the village, water is constantly running—in a strong stream—along the brook, but after receiving the sewage from a drain it disappears near where the road and the brook cross. The channel through the village is thus left dry for a greater part of the year, the water being absorbed by the lower or sandy portion of the gravel at the spot indicated. It appears to be carried along, beneath the surface, by the gravel to its eastern extremity at the lower end of the village, where water is again found in the brook. The base of sandy clay [in the gravel], although irregular, is probably persistent, and prevents the downward percolation of the water. The dryness of the channel through the length of the village, and the reappearance of water at the lower end, show that the water having once entered the gravel is kept therein for that distance, either by slight difference of level, or by the coating of rain-wash from the clay-covered hills."

"The parish well is sunk through (and evidently derives its water from) this sandy portion of the gravel, thus intercepting in its course water into which, within a distance of 250 yards, sewage matter has been discharged."

"There is evidently direct communication, by fissure in the chalk, or otherwise, between the now dry channel and the parish well, as in times of flood, when the channel is full, the water in the well rises to a corresponding height, and becomes cloudy."

Speaking of the fever Buchanan says: "Of the 45 cases, five have occurred among the 118 people who get their water from private wells. Two of these five, however, had been lodging in houses supplied by the public well, and two others of the five are . . . of new occurrence, and . . . uncertain. Thus only one positive case occurred in four months among the 118 persons who drank water from private wells. The remaining . . . cases occurred among 88 persons who had no source of water-supply except the parish well, some of them, however, occasionally taking water, when it could be had, from the brook. There were thus, among persons getting water from private wells, less than 3 per cent. attacked by fever; among persons getting water from the

[1] *Twelfth Rep. Med. Off. Privy Council,* 1870, p. 72.

parish well, over 46 per cent. attacked. No other general difference . . . can be observed between the families which suffered and those which did not suffer from the fever."

A footnote states that 19 fresh cases were pretty equally divided between the public and private well-supplies.

He comes to the conclusion that the fever originated from two cases imported from London, and was distributed by water, saying: "I think it is sufficiently proved that the water was the immediate cause of the epidemic," and he concludes thus:—"The measures that appear necessary for the permanent improvement of the village, and for putting it in a condition in which such epidemics as the present should be impossible, are essentially the supply of pure water and the safe disposal of all excrement. . . . The existing wells will, after the effect of their recent cleansing and disinfecting has passed away, remain sources of danger to the people for some time after the necessary action has been taken for keeping all excrementitious matter out of their neighbourhood; and it is desirable that a new well should be sunk into the chalk at the lower or east end of the village, in a place distant from houses, and beyond the reach of any contamination."

Stock.

H. B. Woodward has noted that "Stock, otherwise a very healthy place, from its good situation, suffered much, in 1870, from the impurity of the water. This was wholly got from land-springs, issuing from the junction of the sand (Bagshot) with the loamy upper beds of the London Clay. From the great amount of sewage that was mixed with the water, the inhabitants, and particularly the children, suffered much from scarlet fever. There was, I was told, but one well in the village, and probably the water from this comes from the same source."[1] Presumably the word "scarlet" has got in by mistake, as scarlet fever has never been traced to water.

Southend.

In his report dealing with the outbreak of Typhoid in 1890 Dr. Thresh exonerates the water-supply on the following grounds:—

(1) Examination of the water chemically and microscopically betrayed no organic pollution, and chemically there were no significant variations from normal conditions.

(2) The surface-water at the various sources of supply was properly excluded by the well-linings. (There is a covering of some 200 to 380 ft. of clay between the surface-beds and the beds from which supply is pumped).

(3) The town is in part supplied sectionally, one section by one source and another section by another, and the distribution of cases contradicted any assumption of infection by contamination of any one source of supply.

(4) He saw no signs of indrawing of sewer- or other infected water into the joints of the mains.

(5) The proportions of cases among women and among children under 15 were low. As these are more markedly water-drinkers

[1] *Geol. Survey Memoirs.* The Geology of London, etc., 1889, vol. i, p. 278. Reproduced from The Geology of the London Basin, 1872, p. 327.

than men, these proportions should be high in a water-borne epidemic.

(6) Taking Southend as a whole 5·7 per cent of the houses were invaded by Typhoid in 1890. But of the houses invaded in the previous year 25 per cent. were again invaded in 1890. This tendency to recur in certain houses was not compatible with infection by a water-supply common to all.

(5) and (6) also contradict infection by milk. Also cases occurred impartially among customers of different milk-purveyors.

He attributes the Typhoid to sewer-infection for the following and other reasons:—

The general condition of the sewering in the invaded parts was not satisfactory (bad-jointing of main sewers and direct or badly trapped connection between houses and sewers), and might lead to infection by sewer-gas specifically infected by Typhoid stools, etc.

The general scheme of sewerage (small-bore mains, subject, owing to defective valving, to sea-flooding at exceptionally high tides) would have aggravated matters by causing a high gas-pressure in the sewers.

The invariable occurrence in autumn is also incompatible with water-borne Typhoid.

In his Report to the Local Government Board, No. 105, on Infectious Diseases in Southend, made in 1896, Dr. R. B. Low says: "The Reports of Mr. Shirley Murphy and Dr. Thresh exonerated the water supply . . . from any suspicion that might have attached to it as an agency in the dissemination of enteric fever," and that "the great depth of the wells . . . and the fact that they pass through an impermeable layer of London Clay . . . render it very improbable that the water . . . can become polluted by soakage of sewage matter from the surface. . . . The lining of the wells . . . has been carefully done, and is calculated to prevent all chance of surface water finding admission," and he adds "it appears that pollution of the wells in any of the usually recognised ways has been completely guarded against. Moreover, the incidence of the enteric fever in the borough has not resembled what is ordinarily met with in water-borne epidemics."

In 1901 Dr. J. T. C. Nash reported on the water-supply, to the Health Committee, owing to complaints having been made. "That these complaints were well founded was proved by the fact that numerous living animalculæ (Daphnia) were found in the water, together with the dèbris of the bodies of others. These organisms are characteristic of pond water." Mr. Bilham, the Manager of the Water Works, "had no doubt that the animalculæ in the water . . . came from a new reservoir." On cutting off the supply from this reservoir, emptying the reservoir, and flushing the water-mains, no further complaints were made. This is an interesting case of slight contamination in an uncovered reservoir.

Since the above Reports were written it has been proved that the outbreaks of fever were due to shell-fish from the polluted foreshore. Now that the foreshore has been protected, a case of typhoid rarely occurs.

Writtle.

A Report to the Chelmsford and Maldon Rural Sanitary Districts by Dr. J. C. Thresh, in 1891, on the water of Writtle and Oxney Green, contains 50 analyses of 47 well-waters (all the known wells but one in the village of Writtle and Oxney Green as distinct from the parish of Writtle), and five of five spring-waters; the springs being unpolluted and from the same (or a similar) patch of Gravel as that in which the wells are sunk.[1] (The well by the roadside half-way up Oxney Green is different. For analysis see A, p. 465.)

The results of the analyses are given in a table. They are summarised in the Report as follows:—

In the (pure) spring-waters the total solid matter was 28-30 grains per gallon, and the hardness 20-26°. None of the village well-waters had less than 30 grains of total solids, few less than 40, and many 90 and over. In hardness some of the wells compared favourably, but their average was much higher than that of the springs. Also in the springs the hardness was nearly all removable by boiling, while in the wells the Permanent Hardness was often very excessive. (In addition to the consequent waste of soap permanent hardness in such waters is referred to in the Report as causing constipation and possibly indigestion.)

In many parts of the district the conditions (of the well-shaft or surrounding or both) were permitting of entrance of unchanged or slightly changed sewage, as shown by the high Organic Ammonia and Oxygen absorbed.

In other cases the sewage had been altered by passage through 'live earth,' and was possibly innocuous, but these conditions it is pointed out were liable to be upset by extra rapid soakage after heavy rain.

This sewage-contamination, changed or unchanged, is shown by the Chlorine-figures (Chlorine from the salt in Urine), and by the excess of Nitrates (formed by oxidation of sewage or other filth).

The pure springs contained 1 to 1½ grains of Chlorine per gallon. Few of the wells had less than 3 and nearly half had 8 or more.

The springs contained ·25 to ·45 of Nitric Nitrogen; only 4 of the wells had less than ·5 grains, the majority had 1 to 3, and many even exceeded 3.

Of the 50 samples from the 47 wells about 9 contain so little oxidised sewage-matter (as measured by the Nitric Nitrogen and Chlorine), and so little organic matter (as measured by the Free and Organic Ammonia and Oxygen absorbed), that one might fairly infer only a slight risk of the entrance of unchanged sewage, but with such porous soil this risk could not be considered negligible. "All the other waters must be considered unsafe; some of them are very filthy and totally unfit for any household use."

There was only one public pump in the village, fortunately yielding one of the best waters. The Brewery Company kindly permitted the use of one of their taps to all comers, this also yielding one of the best waters.

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[1] The subject is also referred to in his 'Report on the Water Supply of Essex,' 1901.

One well (No. 16 of the Report) had two pumps, Hockley's of lead and Dent's of iron. Water from the latter contained iron and increased quantities of nitrites and ammonia from the action of iron on the nitrates.

Change due to rain is shown by 22 (a) and 22 (b) of Draw-well in Deadmans Lane (a) in dry weather, (b) after heavy rain. Variation (cause not stated) is also shown in 37 and 38 from Everard's, near Chandlers.

[None of the above damning comments apply to the Pump-wheel Well half-way up Oxney Green (see A, p. 465), the water of which is well spoken of in every way.]

In addition to defect in quality the quantity of water was also insufficient, and many new cottages were under construction.

The village now has a public supply from a deep well (see p. 324).

Rainham.

E. Evans, in his Report to the Local Government Board in 1894 (No. 77, p. 2), says that: "Shallow wells, from 6 to 12 ft. deep, in the gravel constituted until recent years the sole water-supply of the village. In 1888 the South Essex Water Company extended their mains into Rainham, but up to the early part of last year very few households had availed themselves of this supply. Even for houses erected within recent years, wells have been sunk within half-a-dozen yards of privy pits and cesspools; in but rare instances have the wells been placed at such a distance from dwellings as to be reasonably safe from polluting agencies of the above sort."

Chelmsford and Widford.

In 1903 Dr. Thresh treated of an epidemic of diarrhœa which occurred in the borough of Chelmsford and the village of Widford in the summer of that year, from July 23rd onward, with over 1,000 cases and 14 deaths:[1]

A detailed investigation was made, not only in the two places mentioned, but also in the parts of Writtle, Springfield and Great Baddow, next to the borough. On comparing the attack-rate in the parts getting water from other sources than the borough-mains with that in the part supplied from the mains, it was found that whilst in the former case the percentage of persons attacked was only 1, in the latter it was 21·5.

There was no evidence that milk or any other article of food could have caused the outbreak, and in no other part of the Chelmsford Union was there any great prevalence of diarrhœa.

The water-supply of the borough, therefore, seemed to be implicated; but only the eastern part of the town was affected, that is, the part supplied with mixed water from the Burgess spring and the deep well (see pp. 74, 116); the part supplied from Admiral's Park spring was not affected.

On examination, however, nothing was found pointing to the possibility of pollution of either the Burgess spring or the well; but near the latter there was a small uncovered reservoir into which the water of the well was pumped and through which it flowed, to mix with the water from the spring, in a larger covered reservoir.

[1] British Medical Journal, Sept. 26, 1913.

"This small reservoir was not bricked up above ground level, hence during a heavy rain water from the ground around would run into it," a mistake which we have often seen and commented on, and which seems to have been made in this case by the engineer's designs not having been strictly followed. Moreover, adjoining one end of this reservoir, or tank, was a patch of garden, which was manured with road-scrapings. "This tank was in use up to August 21st, when its pollution was suspected and the deep well water was at once diverted and pumped straight into the larger reservoir . . . and two or three days after this the epidemic came to an abrupt termination."

Confirmatory evidence was given by the fact that whilst a "sample of water collected at Widford towards the end of the epidemic period . . . contained so many bacteria that the gelatine plate was liquefied" before they could be counted, a sample from the same source, taken on September 2nd, "contained very few organisms and gave none of the reactions which had characterized the previous sample." Clearly, therefore, between the two dates "the water had undergone a marked change accounted for by the cutting out of the polluted reservoir."

The conclusion come to is "that about July 23rd the small reservoir became contaminated with pathogenic organisms from garden soil, that this contaminated water caused the epidemic prevalence of diarrhœa in the district throughout which it was distributed . . . and that the cessation of the epidemic was due to the cessation of the pollution."

The death-returns confirm this conclusion, for from July 1st to 23rd no death occurred in the borough or district from diarrhœa, whilst "during the epidemic period 12 deaths occurred in Chelmsford, 2 in Widford, and none in the remainder of the Chelmsford Union," and the deaths "all occurred in the district to which the implicated water was supplied."

This is a case showing how it is not only needful to get a supply of good water, but also to keep that supply pure when you have got it.

Romford Rural District.

In reporting to the Local Government Board in 1904, Dr. F. St. G. Mivart said:—"In certain localities where the public water service (of the S. Essex Water Co.) is not available considerable difficulty is found in obtaining a supply of wholesome water. In and around Havering-atte-Bower, and in the hamlet of Noak Hill this is especially marked and in these places water is got from private or quasi-public wells," the depth of which is not more than 30 ft. "I was assured that the Rural District Council had expended considerable sums in . . . searching for water hereabouts, the services of a 'diviner' having been invoked without avail."

"In other parts of the district, even where public water mains are readily accessible, numerous private wells were met with. . . . Their depth does not usually exceed 15 feet." In many places the water in these wells was variously polluted, notably in the parish of Rainham.

"Speaking generally I did not see one well from which water should . . . be allowed to be used for drinking until it had been subjected to expert examination; nor, in most cases, would a

favourable report at any one time suffice . . . to establish such water as generally wholesome, having regard to the nature of the soil and the surroundings of the well."

Earls Colne.

DR. W. W. E. FLETCHER, in his Report on the Halstead Rural District, in 1905, said (pp. 2, 3):—

"The upper portion of Earls Colne is supplied with water to a large extent by a deep private well" at the machinery-works. Other houses "are supplied by various private wells. These are generally shallow . . . dry-steined, and frequently in undesirable proximity to sources of pollution. . . . In the lower part of the village water is obtained from private wells, some of which have been condemned."

Speaking of the part beyond the river [? White Colne] he adds:—"There is no doubt, having regard to the structure and situation of the wells that, generally, water drawn from them must be viewed with suspicion; and indeed certain of the wells are known to supply water unfit for domestic use. . . . At Pebmarsh, in addition to supplies from private wells of the usual unsatisfactory character, there are four public supplies" from pump-wells and a dipping well. "At Greenstead Green there are two public wells." At Little Maplestead and at Colne Engaine there were public pumps.

At Castle Hedingham there were six public wells. In Sible Hedingham twelve. At Great Yeldham there was a public well, at Little Yeldham two public supplies. "In Tilbury Parish there are two public pumps, and two at Ridgewell. . . . In Topplesfield Parish there are six public supplies. . . . At Stambourne there are two," and at Great Maplestead there were two public wells.

In 1914 a public supply was provided for Earls Colne and for houses in other parishes near (see p. 142).

Dunmow Rural District.

DR. BULSTRODE, in his Report of 1908, says:—"The whole district is at the present time very badly supplied with water. . . . . For one of the smaller houses in the district, even in populous places . . . to possess a supply of its own is a matter of rarity, and in the majority of cases the occupiers have long distances to go for water which is not always abundant or of good quality when secured. Many of the wells are obviously liable to pollution from neighbouring privies," etc. "In dry seasons some of the wells become exhausted. . . ."

At Ford, adjoining Dunmow, there were "some seventeen cottages depending for their drinking water upon an open ditch . . . obviously open to pollution."

Dunmow and Felstead now have public supplies.

POSSIBILITY OF POLLUTION OF DEEP WELLS.

Notwithstanding that most of the wells are sunk through 200 or more feet of London Clay, the deep well-waters of Essex not unfrequently contain the *bacillus coli*. Many bacteriologists become alarmed at finding this organism present, believing that its presence is an indication of pollution with manurial or sewage-matter, the natural habitat of the bacillus being the intestines of

men and animals. The problem as to its origin in these waters has not yet been solved. From time to time it occurs in practically every natural water from whatever source, though in very small numbers. A dead fly would undoubtedly infect a certain volume of water, dirt from the soles of workmen's boots is another possible source, and doubtless on occasions road-dust contains the bacillus. In one Essex well the organism was found in rather unusual numbers, and the Water Co. placed the well at the disposal of one of us for a thorough examination. The water in the sunk well was pumped out, and a sample of water obtained from the bore-tube at the bottom was collected and examined. It was practically sterile and contained no bacillus in the least resembling the *bacillus coli*. Water was then allowed to rise in the well, and a sample examined was found to contain a fair number of bacteria and a small number of the bacilli for which we were searching. Pumping was then recommenced and a sample taken from the top of the rising main. This swarmed with bacteria, and contained a relatively large number of *bacillus coli*. The pump was next taken to pieces, and the carbolised tow which formed the packing was found to be in an offensive condition and loaded with bacteria. It was re-packed, and after a time the water delivered from the pump was free from all objectionable bacteria.

At this time inquiries were made regarding the existence of any deep well near, which might have become converted into a cesspool, but there was no deep well for miles, and nowhere in that portion of the county could such a receptacle for sewage be heard of.

In another deep well at the outskirts of a small town, the water was found to contain the *bacillus coli*, and being the public supply to the town the Medical Officer of Health was alarmed. His alarm increased upon finding that before the establishment of the water-works there had been numerous bored wells in the town, and that some of these had been used as cesspools. Further enquiry elicited the fact that when the town was sewered all the houses which had previously drained into these wells were connected with the sewers and the wells filled in. Before these enquiries were completed the water had become free from the organism, and it has not been found in it since. Last year (1913) when enquiring about a deep well at a farm, the tenant acknowledged its existence, but said that a sample of water could not be obtained from it as he had converted it into a cesspool for the farmyard. The well had yielded a water so hard that it was useless, and as the sunk portion was of some depth the farmer thought that he might as well use it as a receptacle for liquid sewage.

These experiences are chronicled so that others making similar investigations may be on their guard as to the possibility of pollution arising in this manner. No doubt the danger is greatest in fissured formations, but even in the compact Thanet Sand and the compact Chalk underlying it polluting matter might travel some distance.

The conversion of a well into a cesspool is wrong. It may result in great harm, and there can be no excuse for it. This holds, of course, for shallow wells as well as for deep ones.

MISCELLANEOUS.

There are subjects which do not readily fit into any of the headings that have gone before, and certainly not into any of those which follow. It is handy, therefore, to have a special heading for such erratics, which are of some interest, partly from a geologic point of view, and partly from a controversial one, the comparative advantages and disadvantages of hard and soft water being a frequent subject of dispute.

GEOLOGIC INFORMATION FROM WELLS AND BORINGS.

The help that geology gives to those who are engaged in work underground is repaid by the valuable records that such work adds to our store of knowledge. One cannot but regret, however, that in many cases no records of borings have been kept, or if kept have been lost, and that in others but imperfect records remain; but it is to be hoped that in future all such work may be duly recorded, and moreover, that accounts thereof may be sent to the Geological Survey, which is apparently the only public body able and ready to act as the collector of all such information.

As regards Essex, besides the obvious general knowledge as to the geologic succession downward, and as to the thickness and character of the various formations in places where they are not seen at the surface, there are some special points, either of practical importance or of geologic interest, on which we are indebted to deep wells and borings for exact information.

In the first place we get to know something of the level of the floor of old rocks, from borings in the county and at no very great distance outside its boundary, and from this we are enabled to make reasonable inferences as to what may occur in places where there is no direct evidence.

The above carries with it the knowledge of the depth to the base of the Gault, and to the base of the Chalk, besides some information as to the formations present between the Chalk and the old rocks, which may not always be the same.

Then we have a great many records showing the level of the top of the Chalk, and also that of the base of the London Clay. These are of importance, and perhaps the evidence is enough to warrant the drawing of the underground contours of those two levels, at all events in parts of the county. They also show lines of disturbance (see p. 11).

Finally the changes in the thickness and character of the Drift have much additional light thrown upon them; indeed, the varying thickness of the Glacial Drift is shown in a way that cannot be realised from open sections.

To sum up, there are two points of great geologic interest in which our knowledge comes from wells and borings: one, at the bottom of the series, is the rising up of old rocks below the Secondary formations, the other, at the top of the series, is the cutting of deep Drift-filled channels in the Chalk. Of the former we know from borings in only three places in the county, at East Ham, Harwich, and Weeley (pp. 144, 184); but borings in Herts, Kent, and Suffolk, give further knowledge. Of the latter we have abundant evidence in the head-part of the valley of the

Cam, at Great and Little Chesterford, Littlebury, Newport, Quendon, and Wendens Ambo (pp. 169, 212, 213, 230–232, 239, 295, 296), with additional evidence over the border in Cambridgeshire. In seven wells at the above places the thickness of Drift proved varies from 137 to 296 ft., and in an eighth, at Newport, no less than 340 ft. were passed through without reaching the base.

It is notable, too, that the greatest thickness of Drift yet proved in the kingdom was in another valley, one side of which is in Essex, that of the Stour, near the bottom of which 470 ft. of Drift were passed through in a boring at Glemsford, in Suffolk.[1]

There are probably many shallower channels of a like kind in other parts of Essex; but the one in the valley of the Cam is the best proved, for a distance of some miles, in the South of England. It was described in some detail in 1890,[2] and further evidence is given in this Memoir. Besides the wells quoted above there are others in the neighbourhood showing a good thickness of Drift, though less than any of those just given.

A similar channel, though not so deep, in the valley of the Stort, and mainly in Hertfordshire, has been described by Dr. A. Irving in various papers.

THE EAST ANGLIAN EARTHQUAKE AND UNDERGROUND WATER.

In 1884 took place the remarkable earthquake which was noticed especially in Essex, and formed the subject of the first of the Special Memoirs of the Essex Field Club.[3] Besides having marked effects on the surface, with much damage to buildings, there was also an effect on underground water, as recorded in pp. 155-162 of the work alluded to, from which the following remarks are taken, except the first entry (relating to an effect at the surface), the description of which is from pp. 76, 77.

At West Mersea a crack ran along the slope for about 200 to 300 yards, starting from St. Peter's Well, the wooden cistern at the mouth of which is on the shore above high water, a little south-west of the church. The crack was almost obliterated when the authors visited the place, "but we were informed that on the day of the earthquake it was more than two yards in depth and wide enough to insert the fist. There can be no doubt that this crack was opened by the earthquake movement," but it is regarded as only an incipient landslip. "The water of the well, which usually runs out of the cistern in a clear and gentle stream, was jerked forcibly out by the shock, and afterwards ran turbid with suspended matter for about two hours, after which it resumed its original clearness."

"At Cross Farm, a little over a mile E.N.E. of W. Mersea, the disturbance opened another small E. and W. crack, from which two little fresh-water streamlets spouted forth and trickled down towards the house for 8 or 9 hours, and then ceased to flow . . .

[1] The Water Supply of Suffolk, 1906, p. 58.

[2] *Quart. Journ. Geol. Soc.*, vol. xlvi, pp. 333-340.

[3] Report on the East Anglian Earthquake of April 22nd, 1884. By Professor R. Meldola and W. White. 8vo. Lond., 1885. Pp. x, 224; two plates (maps).

the streamlets, which were about 10 yards apart and one inch wide, were charged with a reddish-coloured sand."

"At a well near these streamlets the water was made to rise about two feet, and was rendered turbid."

It is added (p. 156) that, as to the Cross Farm streamlets, "it may be suggested that the temporary squeeze to which the water-saturated beds were subjected by the passage of the wave of compression was the immediate cause of the water appearing at the surface, the crack opened by the disturbance at this place affording the easiest channel of escape."

Turning now to deep-seated water, the following is recorded of the two wells at the Colchester Waterworks:—"Previous to the earthquake the water-level had been gradually sinking, and the Committee had decided that a deepening of the wells would be necessary, when the shock came and caused a rise of 7 to 7½ feet, this increased level being maintained for about six months"; but then the water-level fell, and in August, 1885, was only 2 ft. above the pre-seismic level.

"All the other wells in the neighbourhood of Colchester were affected in a similar manner, but, as no systematic measurements were made, not much is known beyond the general fact. . . . At the Castle Brewery well the water is said to have returned to its former level in November . . . at the Eagle Brewery the water level in the well was 22 feet below the surface before April 22nd, but after the shock it had risen to within 18 feet . . . and continued at that level till the end of August, 1884."

Of Messrs. Courtauld's well, Bocking, it is said:—"The earthquake also caused a rise in the level of the water, . . . and as systematic measurements of the level have been taken weekly for some years past, it is possible to represent the effect in a more precise form." A summary of these gaugings, from 1883 to 1887, is given, from another source, under the description of the well (see p. 99).

Comparing the water-levels of 1883 and 1884, our authors say:—"These results show that the earthquake caused a rise of 19½ inches, the rise increasing up to June 3rd, after which the level was falling."

"This effect of an earthquake shock in raising the level of subterranean water has not often been recorded, although such results must have frequently been observed in earthquake countries." One may add that it is satisfactory to find that an earthquake may have a benevolent action, at all events putting off the evil day of well-extension.

"Numerous conjectures as to the cause of the rise of water in these wells have been advanced, such as the collapse of subterranean reservoirs, general alteration in the level of the land, &c., but none of these appear to us to bear the test of critical examination," in which we concur, as also in the acceptance of the explanation given by C. E. De Rance (in *Nature*, May 8th, 1884), that the shock caused a widening of the fissures in the Chalk through which the water flows, the increased flow thus caused leading to a rise in the water-level.

EFFECT OF PUMPING ON WELLS AND SPRINGS.

The effect of pumping at one place on water-level at another is not much in evidence in Essex; but there are two cases, one illustrating a near effect and the other a distant one.

At Stansted Mountfitchet pumping at the Nursery Well lowered the water in the Waterworks Well about a third of a mile northward (*see* p. 269). Their combined pumping also at times lowered the water in the watercress-beds, more than half a mile westward of those wells. This water comes from springs, the decrease in the outflow of which at a certain time of day is explainable only by pumping; it is a different thing from seasonal fluctuation, and lasts for a short time only. The above was learnt on the ground in 1900, and it is an interesting example of the effect of comparatively small pumping.

Long ago MR. J. BEARD wrote, "about fifty years ago a well was sunk in the dockyard at Sheerness which by excessive pumping did drain the deep wells at Southend"; but he goes on to say, of the waterworks well, sunk 14 years before:—"Nothing from Sheerness has disturbed this well."[1]

On the other hand, "It has been recorded, by the Admiralty Department of Works, that when the Shoeburyness boring . . . was being made, the level of the water in this (? Sheerness) well was lowered 17 feet. The distance is about six miles."[2]

It is certainly difficult to understand how such sympathy between the water of two counties could reach for so great a distance; anyhow it seems a case of tit for tat.

The experience of the Southend Company is that wells within 1½ miles affected each other.

HARD AND SOFT WATER.

The question of the relative merits of hard and of soft water in regard to health having been discussed by one of us in connection with Essex, it is well to give an account of his work, the matter being of much interest.[3] DR. THRESH says:—"I have . . . not succeeded in obtaining any reliable evidence pointing in one way or the other, but I have heard many medical men express the opinion that amongst the users of soft water fewer suffer from digestive disturbances than amongst the users of hard water. That hard water produces 'stone,' 'gout,' or 'rheumatism,' or that soft water induces 'rickets' in children there is not a tittle of evidence to support." Having been obliged to limit investigation to the general death-rate, and to that from certain diseases, he says:—"There is no reason to suppose that cancer, phthisis, or typhoid fever are affected by the hardness or softness of the water. . . . To avoid introducing the effect of purity or impurity, I have limited my investigations to the Urban Districts in which all the water supplies are admitted to be of excellent quality, and I have divided these into groups according to the 'hardness' of the water supplies. . . . The 18 towns in Rural Essex are divided into three groups. . . ."

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[1] *Proc. Lit. Phil. Soc. Manchester*, 1874, vol. xiii, p. 91.
[2] *Geol. Survey Memoir*. The Water Supply of Kent, 1908, p. 193.
[3] County of Essex. Report of the Medical Officer for 1910, pp. 138-142.

1. **Hardness of water** under 10° (per 100,000). Soft water areas.
2. „ „ between 10° and 20°. Moderately hard water areas.
3. „ „ 20° to 30°. Hard water areas.

The conclusions in this Report were based upon the statistics for one year. On a later occasion, DR. THRESH says[1]:—" When the Census returns for 1911 were received and the Registrar General had supplied me with factors for the correction of the death-rates on account of differences in age and sex distribution of the population . . . I decided to again consider the subject and to take a period of five years as the basis for comparison. The results now given, therefore, are much more reliable than those published in 1911, but they support entirely the conclusion at which I then arrived." The following figures therefore are condensed from the later Report, and are the *averages* for the years 1907 to 1911.

The *Soft Water Areas* include Burnham, Leigh, Maldon, Shoeburyness, and Southend, with a population of 77,350 (increased to 90,440 in 1912) and a death-rate varying from 8·9 to 11·2, on the total 11 (decreased to 10 in 1912).

The *Moderately Hard Water Areas* include Braintree, Brightlingsea, Colchester, Saffron Walden, Witham, and Wivenhoe, with a population of 64,690 (increased to 67,050 in 1912) and death-rates varying from 7·9 to 12·8, on the total 11·5 (decreased to 10·9 in 1912).

The *Hard Water Area* includes Clacton, Chelmsford, Epping, Frinton, Halstead, Harwich, and Walton, with a population of 53,400 (increased to 56,480 in 1912) and death-rates varying from 8 to 14·1, on the total 11·2 (decreased to 9·9 in 1912).

Besides these three groups there are two others, of places supplied by large undertakings, as follows:—

The *Area of the South Essex Company* (water varying in hardness according to the source): classed as moderately hard, including Barking, Brentwood, Grays, Romford, and Romford Rural, with a population of 93,490 (increased to 99,480 in 1912), and a death-rate varying from 8·8 to 13, on the total 11·2 (decreased to 9·9 in 1912).

The Area of the Metropolitan Water Board, Hard Water, including Buckhurst Hill, Chingford, East Ham, Leyton, Loughton, Waltham Abbey, Walthamstow, Wanstead, and Woodford. These nine places also get water from different sources, but form a Hard Water Area. The population was 421,300 (increased to 454,310 in 1912), with death-rates varying from 8·5 to 12·1, on the total 11·1 (decreased to 10·6 in 1912).

In order of death-rates, for 1907 to 1911 (average) we have the following result:—

Soft Water Area, 11 (10 in 1912).
Hard Water Area, Metropolitan, 11·1 (10·6 in 1912).
„ „ „ Country-towns, 11·2 (9·9 in 1912).
Moderately Hard Water Area, South Essex Co., 11·2 (9·9 in 1912).
„ „ „ „ Country-towns, 11·5 (10·9 in 1912).

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[1] Report for 1912, pp. 27-35.

"It is obvious that there is no co-relation . . . between the hardness of the water and the death-rates."

On the average for the five years, the difference between the death-rates for the area with soft water and for the area with hard water is in the Metropolitan area only ·1 per 1,000 and in the country-towns only ·2, whilst the death-rate in the moderately hard water areas, together, exceeds that in the hard water areas by ·1 to ·3 per 1,000. "These differences are so slight that only one conclusion can be deduced, namely, that the character of the water supplies in the county had no effect upon the death-rates."

The deaths from cancer, phthisis, and typhoid fever are given separately, and the figures show some great variations.

"Taken as a whole there is a greater prevalence of Cancer in the soft water areas . . . but this is chiefly due to the number of deaths . . . in Southend. . . . There is no evidence, therefore, of a connection between the hardness or softness of water and the prevalence of Cancer. . . ."

"The soft water area has the highest death-rate from Phthisis, but the reason is exactly as is given for the excessive mortality from Cancer. Patients in the early stage of the disease flock to health resorts in the hope of arresting its progress. . . . The figures lend no support to the view of the nature of the water having any influence, whatever, over the prevalence of the disease."

As regards typhoid fever, "The great variations here, are against the assumption that the hardness of the water bears any relation to the prevalence or mortality from this disease. For example, the highest mortality occurs in one moderately hard water area, and the lowest in another area in part supplied with the same water, and in part with a harder water, whilst the area with the softest water has practically the same death-rate as the area supplied with the hardest water."

It is pointed out in the earlier Report that "although there is no proof that hard water affects the health, there are certain advantages arising from the use of soft water," in relation to boilers, etc., to the use of detergents, and to cooking; so that in some cases softening works may be economical.

In the later Report it is noted that the statistics given are "of considerable importance as showing that the soft waters of Essex which invariably contain considerable quantities of common salt and sulphate of soda are excellent for drinking purposes and well adapted for all the purposes of a public supply."

Finally, it is to be noted that the conclusions are based on large figures, and so avoid the chances of error that are so likely to occur when dealing with small figures.

TEMPERATURE OF WELL WATERS.

Occasional records of the temperature of the waters is given under a few of the accounts of wells; but as a very general rule no observations of the sort have been recorded. It is satisfactory, however, to have a record for 25 wells of the wide-spread Southend Company, taken by one of us in the course of his official work in the county, and all but one in the month of May, 1914.

The temperatures were taken from the water as it reached the surface in the rising main.

In the table the wells have been arranged in the order of the temperature of the waters, beginning with the lowest. The temperatures remain fairly constant from year to year.

In examining this table we see, as one would expect, that the temperature of the water has nothing to do with the level of the ground; but neither does it follow the depth of the well, as one would have thought it might have done; for instance, the deepest well is 16th in the order of temperature, and the lowest temperature is 15th in the order of depth; the fourth only holds the same place in both, and there is a general irregularity. When, however, we come to the depth to the Chalk (not known in several of the walls, which have not been carried deep enough to tell this) there seems to be some connection with the temperature; and, as a rule, the shallower depths to the Chalk give the lower temperature, though the 16th Southend and the 9th Prittlewell (with great depths to Chalk) are out of place. The greatest depth has the highest temperature and the lowest three depths to the Chalk come in due order with the lowest three temperatures. The depths to the Chalk near 500 feet come fairly near together.

Postscript to the following table.

Observations made in July, 1915, show many small differences, mostly increases, the only decreases being at Leigh and Vange Main Pumping Stations, and these only to the extent of ·2 and ·1 respectively. The increases above ·2 are as follows:—

Pitsea to 14·8; Vange Auxiliary to 14·3; Nevendon to 15·4; Prittlewell to 17·, an increase of 2·2, presumably due to work lately done to increase the yield; Southend to 16·8; Downham to 16·6; Great Wakering to 17·8, an increase of 1·1; Oakwood to 17·9, bringing it to the highest figure.

These new figures are more in accord with the depths to the Chalk than are the old ones.

Observations on three new wells, not taken before, have been added at the end of the table, p. 72.

A suggestion, from E. C. Bilham, engineer to the Company, that the figures are more or less related to the depth to the base of the London Clay, though it holds in a general way, as with the depth to the Chalk, does not hold in detail, only the first two entries (Fobbing) coming precisely in place, with depths to the base of the London Clay of only 157 and 171 feet. The lowest entry, Southchurch, with 462 feet, just escapes its proper place, being exceeded by Ramsden Heath, with 467. The subject is having further attention.

Temperatures of Southend Water Company's Well-waters.

Name and number of Well.	Ground-level in feet above O.D.	Depth of Well or Boring, in feet.	Depth to Chalk in feet.	Source of most Water.	Date of Observation.	Temperature of Water, Centigrade Degrees.
12. Fobbing Auxiliary (p. 157) ...	65	551	298½	Lower London Tertiaries. Small quantity from Chalk	May 5, 1914 ...	12·7
10. Fobbing Main (p. 157)	70	Was 559½, now 756	314½	Through the Chalk. Some quantity from Lower London Tertiaries	„	13·
23. Vange West, *see* Fobbing (p. 159)...	85½	398 (?bulk of water at 290)	393¾	Lower London Tertiaries ...	„	13·6
3. Eastwood (p. 140)	46	871¾	427¾	„	May 13, 1914	14·2
14. Pitsea, *see* Vange (p. 286)	27½	268	Not known	„	May 5, 1914 ...	14·5
13. Vange Auxiliary, *see* Fobbing (p. 158)	38	257¾	„	„	„	14·6
17. Nevendon, *see* Pitsea (p. 238) ...	45	Was 273½, now 452	411	„ (some through Chalk)	„	14·7
24. Sutton, *see* Eastwood (p. 149) ...	24	325¾	Not known	„	May 13, 1914	14·7
2. Prittlewell, *see* Southend (p. 263)...	101½	876½	571⅓	„	„	14·8
26. South Benfleet (p. 260)	29½	642	461	Doubtful	May 5, 1914 ...	15·
11. Vange Main, *see* Fobbing (p. 158)...	44	330	Not known	Lower London Tertiaries ...	May, 1910 ...	15·
15. Bowers Gifford (p. 101)	39½	317	„	„	May 5, 1914 ...	15·2
6. Picketts, *see* Eastwood (p. 149) ...	130	801	496	„	May 13, 1914	15·2
21. Slice's Gate, Well, *see* Billericay (p. 95)	125	400	Would probably be same as boring No. 19	„	May 5, 1914 ...	15·6
22. Wickford (p. 310)	37	363¼	Not known	„	„	15·9
1. Southend (p. 261)	108	900	598 (or 604?)	„	May 13, 1914	16·1
18. Leigh, *see* Southend (p. 261) ...	137⅔	600	520	Doubtful	„	16·2
7. Thundersley (p. 278)	85	675⅓	464	Lower London Tertiaries ...	May 5, 1914 ...	16·2
20. Downham (p. 140)	73	438	Not known	„	„	16·2
5. Nobles Green, *see* Eastwood (p. 147)	65	856¼	527 (or 529½?)	„	„	16·5

Temperatures of Southend Water Company's Well-waters—(continued).

Name and number of Well.	Ground-level in feet above O.D.	Depth of Well or Boring, in feet.	Depth to Chalk in feet.	Source of most Water.	Date of Observation.	Temperature of Water—Centigrade Degrees.
16. Great Wakering (p. 175)	38	618½	594½	Lower London Tertiaries ...	May 13, 1914	16·7
8. Burches, *see* Thundersley (p. 279)...	135	845	498¼	„	May 5, 1914 ...	16·8
4. Oakwood, *see* Eastwood (p. 148) ...	115	867½	581⅔	„	„	17·4
19. Slice's Gate, Bore, *see* Billericay (p. 95)	125	900	499½	Doubtful	„	17·6
9. Southchurch, *see* Southend (p. 263)	86	771½	619	„	May 13, 1914	17·8
Barling	18	395½	Not reached	Lower London Tertiaries ...	July, 1915 ...	14·6
25. Wakering Wick, *see* Great Wakering (p. 175)	19	446	Not known (? same as boring close by, 599)	„	„	17·0
27. Ramsden Heath (*see* p. 244) ...	187	501½	Not reached	Lower London Tertiaries ...	„	17·4

The notes of the three new wells below the line have been added from later observations.

SUPPLIES FROM SPRINGS.

In a county like Essex, with so large an area of a rural kind, over parts of which gravel and sand form the surface, many places must depend on springs for their supply. Moreover, even the larger towns (away from the metropolitan area) depend partly on springs for their water, as is the case with Colchester and Chelmsford.

Sometimes even water is carried from a spring in a very rudimentary way. Thus, from the *Essex County Standard* of 25 April, 1908, we learn that: "In Abberton, Fingringhoe, and Langenhoe, drinking water brought from the spring just off Whalebone Hill is carted round and sold by the bucketful at people's doors."

The various supplies will now be described in alphabetic order of the places of the springs; but there are many small cases where there is a joint-supply from wells and springs, which will be found under the former heading, as noted in the Index.

Abberton.

Ordnance Map 234, new ser. (Essex 36, NE., SE.).
Geologic Map 48, SW.

According to Dr. THRESH's Report of 1901, p. 132, this place was very badly off for water, the only public supply being then brought from a spring at some distance and sold at a halfpenny a pail.

Two private wells (? at Pantile Farm, see pp. 85, 86) are of some advantage to the parish.

Alphamstone.

Ordnance Map 223, new ser. (Essex 12, SE., 17, NE.). Geologic Map 47.

Dr. THRESH's Report of 1901, p. 138, says that there was a spring with a public dipping place. In 1896 chemical analysis showed that the water was suspicious. There were a few private wells, but many people depended on ponds.

In 1911 an analysis of the water at the dipping place showed it to be fairly good.

Asheldham.

Ordnance Maps 241, 242, new ser. (Essex 63, NE.). Geologic Map 2.
Southminster Waterworks. 1894.

Dr. THRESH. Report on the Water Supply of Essex, 1901, pp. 108, 109.
Spring yielding about 30,000 gallons a day.

In enlarging the underground tank (? in 1900) fresh springs were tapped and the supply nearly doubled. There are other springs near. The water is fairly soft and of excellent quality (for analysis see p. 346). The spring had been but little affected by recent successive dry seasons.

According to the Report of 1905, p. 39, the yield was 50,000 gallons a day, much more than was needed. The cottages near these works are supplied.

The springs are from gravel.

Ashen.

Ordnance Map 206, new ser. (Essex 5, SW.). Geologic Map 47.

In 1901 there was no public supply and the place was badly off for water. Now there are two public supplies from springs, one in Church Field, the other on the Ridgewell Road. The water is stored in covered reservoirs. There are a few private wells.

Bartlow End (the village of Bartlow is in Cambridgeshire).

Ordnance Map 205, new ser. Geologic Map 47.

According to the Report of the Medical Officer for 1912 about 15 houses are supplied from a reservoir, getting its water from a spring.

Bradwell.

Ordnance Map 223, new ser. (Essex 25, SE., 26, SW.). Geologic Map 47.

Of the hamlet of Blackwater, which he describes as on the main road from Braintree to Coggeshall, Dr. W. W. E. FLETCHER says, in his Report to the Local Government Board, No. 244, 1906, p. 8, "The water supply is derived from springs which feed a pump-well opposite the Vicarage garden. From this well surplus water flows to another roadside pump-well, and from this again there is an overflow to a roadside open tank. The supply is said to be abundant. As to quality I have no information, I can only say that the water is bright and clear."

Blackwater may be partly in the parish of Patteswick.

Chelmsford.

Ordnance Map 241, new ser. (Essex 52, NE.). Geologic Map 1, SE.

In 1890 T. V. HOLMES noticed "the new water-works at Rainsford End, about half a mile north-west of Chelmsford railway station."[1] He remarks that "as the Glacial sand and gravel frequently forms a considerable breadth of ground . a somewhat large quantity of rain sinks through it, and is thrown out here and there as springs," by the underlying London Clay. "One of them has been utilized for the supply of Chelmsford. The district around being thinly populated, it is possible that the water may remain sufficiently pure for . . . many years to come, though its purity can never be quite above suspicion." A conclusion that holds in many other cases, and which must be faced.

Dr. THRESH's Report on the Water Supply of Essex, 1901, pp. 89-91, 94, 95.

Burgess Well Springs.—The chief of these rises in a kitchen-garden, west of the centre of the town. It is enclosed in a covered reservoir of 34,000 gallons capacity, whence the water is carried by an iron pipe to Harrington's Market Garden, where it flows into a tank, which also receives water from two other springs, rising in the garden, the water of which was used for certain watercress-beds and filtered afterwards. From the tank the water goes in iron pipes to the Mildmay Yard Reservoir, where it is mixed with the well-water.

The yield of the Burgess Well Springs has been estimated at 70,000 gallons a day; but in July, 1896, they were scarcely yielding 20,000. The water from them is apparently liable to contamination from various sources.

Admiral's Park Springs rise in a reservoir capable of holding 173,000 gallons, whence the water is pumped up into a water-tower. The quantity supplied (to the North Ward only except in cases of emergency) is calculated to be about 100,000 gallons a day.

The yield of all the springs is liable to fluctuation, and Mr. SASSE gives the yield of those of Burgess Well as 35,000 gallons a day in 1898, the Admiral's Park Springs then yielding 100,000, whilst in July, 1899, the figures were 70,000 and 85,000 respectively.

In his Report to the County Council for 1912, Dr. THRESH, quoting the Medical Officer, says that the water from the springs in Admiral's Park was found to be polluted. With the well dry there seemed to be three separate springs breaking out in the well-bed. With a view of tracing the source of the springs the well on Bundick's Hill was deeply stained with fluorescine; but after five days no stained water showed itself at these springs. At the same time holes 3 ft. deep were dug into the ground on the further side of the Admiral's Park well, and were filled with water deeply stained with fluorescine, none of which appeared in the well. It was found that the water from the well-roof could get into the well, and apparently had been doing so for some time, through the well-wall, after falling on the ground. Contamination in this way seemed feasible, and the fault was at once corrected, by thorough precautions. Samples of the water afterwards sent to Dr. DYER and Dr. THRESH were reported on most favourably, and on June 28th (1912) the water was again used.

In a paper read to the Institution of Municipal and County Engineers in 1914, Mr. P. T. HARRISON, the Borough Engineer, gives the average daily

[1] *Essex Naturalist*, vol. iv, pp. 82-84.

Chelmsford, cont.

supply, in July, 1913, as 58,000 gallons from Burgess Well and 87,000 from Admiral's Park.

The fountain in High Street was once supplied from a spring. Years ago the water was condemned and the Council proposed to cut off the supply. There was such opposition that the matter was dropped; but the Surveyor quietly connected the fountain to the water-main, and, finding that no one noticed any difference, he again asked for permission to discontinue the use of the spring-water. Again the ratepayers who used the water opposed, saying that the water from the fountain was fresher and sweeter than that from the mains. The Surveyor then acknowledged that he had, without permission, disconnected the fountain from the spring and that town-water had been supplied for a considerable time. The opposition suddenly collapsed.

Chipping Ongar.

Ordnance Map 240, new ser. Geologic Map 1, N.W.

Dr. THRESH's Report on the Water Supply of Essex, 1901, p. 51.

A non-statutory company collected water from a spring, and pumped it into a tank. The spring was some distance from the works and the water was carried down to the pump in open-jointed earthenware pipes. In summer all the water was lost by percolation into the dry soil, and to compensate for this water was drawn from the river and passed through a small sand-filter. He had to report the works unsatisfactory, and could not recommend the District Council to condemn existing wells and to cause the Company's water to be laid on, until steps had been taken to free the water from possible pollution.

The spring is in the Roding Valley, a little north of the town. It has been abandoned, and the supply is taken from the Herts and Essex Company.

Coggeshall.

Ordnance Map 223, new ser. (Essex 26, SW.). Geologic Map 47.

St. Peter's Well. About 100 ft. above Ordnance Datum. A spring rising in a small reservoir. Water 3 or 4 ft. down.

A celebrated ancient well, supplying (1899) a large portion of Coggeshall.

Yield never gauged, probably about 40,000 gallons a day; but see below.

For analysis of the water, see p. 347.

According to Dr. THRESH's Report of 1901, p. 115, this spring gave an almost inexhaustible supply of pure water. Unfortunately the well itself was not sufficiently protected, and during distribution (by gravitation through pipes) the water was liable to further contamination, as it passed through dipping troughs.

The yield of the spring was, however, greatly overestimated, and the water is now little used, the Braintree Rural District Council having provided a public supply, see p. 123.

Colchester.

Ordnance Map 224, new ser. (Essex 27, SE.). Geologic Map 48, SW.

The most notable spring-supply in the county is that from which Colchester gets part of its water, thrown out of the gravel by the London Clay. I had the pleasure of seeing the works in April, 1911, when Mr. J. M. WOOD led a visit of the Essex Field Club to the spot and gave a full description of the water-supply of the district, from which the following remarks are taken[1]:—

"The existence of springs in early times . . no doubt influenced the early inhabitants, and later on the Roman Colony, to establish an important station here. The springs which we know to-day probably formed the water supply of the early communities, and there is ample evidence, from the existence of a number of wells which have been found, that the Romans utilized the gravel beds within the walls of their station."

"Probably the springs just outside the walls of the Roman city at the foot of Balkern Hill, and in the railway cutting by St. Botolph's Station . . . were also used by the early inhabitants. . . . These springs are still in possession of the Corporation, but are used only for non-domestic purposes. For many years they formed the source of the early water works. It is

[1] *Essex Naturalist*, 1912, vol. xvii, pp. 21, etc.

Colchester, cont.

somewhat remarkable that history repeats itself even in water supplies, as it remained for the present community to further utilize the gravel beds . . . but under entirely different conditions, to supplement their deep well supply, by bringing into use those wonderful Lexden springs . . . some mile and three quarters west of the town."

"The site of the present water works is at the foot of Balkern Hill . . in close proximity to the springs. . . It also formed the site of the early water works, constructed in 1808, to supply the town with water from land springs. . . . The engineer . . . was not slow to recognise the advantage of the site due to the existence of the springs, which he freely used. . . . Mr. Peter Bruff stated in 1850 that, in consequence of the springs having to a great extent run low, it was necessary to seek for a more efficient supply. These springs, however, remained in use for many years . . . yielding as late as 1888 some 86,000 gallons per day in summer and probably more in winter. In early days the yield was no doubt considerably more, as many of the springs were diverted and have since disappeared from view for ever when the main sewers were laid. Owing to the advance of medical and sanitary science these springs, which rise or flow under the present inhabited town, were finally abandoned for domestic use in 1890, but are still retained for non-domestic purposes, for supplying the locomotives, &c., at Colchester station. They include the springs in the neighbourhood of the water works yard, viz., Clarks' Meadow Spring and the Sheepen Spring. . . . The spring in the railway cutting already mentioned is not at present utilized."

"In or about the year 1860 . . Mr. Peter Bruff discovered . . . a very strong gravel spring just south of Sheepen Farm on the south side of the valley. . . This was brought home by him to the Balkern Hill Works, to supplement the then existing spring supply, but in or about 1880 . . . the spring was abandoned, and immediately taken possession of to supply Colchester Station by the G. E. Railway. As it did not yield sufficient for their purpose it was given up a few years later. . . It is again in the possession of the Corporation. In 1905, I had the pleasure of bringing it home to Balkern Hill for the second time, to supplement the non-domestic supply. It is reported to have yielded some 100,000 gallons per day in Dec., 1879, but in the summer of 1904 the yield was about 70,000 gallons. "

In 1859 the supply was supplemented from a well (see p. 129), and the wells at Balkern Hill became the chief source of supply, instead of being a supplement to the springs.

In 1905 the wells began to be overtaxed, and then the older process was reversed, the Lexden springs (see further on, p. 78) being taken to supplement the well-supply.

Danbury.

Ordnance Map 241, new ser. (Essex 53). Geologic Map 1, NE.

Works for the Chelmsford Rural District Council. 1891. Extended 1893, 1897.

J. Dewhirst and H. G. Keywood. *Trans. Brit. Assoc. Water, Eng.*, 1903, vol. vii, pp. 62-70, pl. iv (map).

"An example of works covering a large area with small population and low rateable value."

The parishes supplied are Danbury, East Hanningfield, Little Baddow, Rettenden, Runwell, Sandon, and Woodham Ferrers, with an area of 20,892 acres and a population of 3,983, the number of houses supplied being 668. The levels of the district vary from 11 to 350 ft. above Ordnance Datum.

For some years the supply came from Buell's Spring, on Danbury Common, 220 ft. above Ordnance Datum, the yield being then 70,000 gallons a day. This spring being nearly three-quarters of a mile from the highest part of the village of Danbury (for which the works were originally designed) the water was raised to a tank on a tower.

On extension, larger reservoirs had to be built, and later, St. Thomas' Spring, Danbury, with a yield of 18,000 gallons a day, was acquired.

In Dr. Thresh's Report on the Water Supply of Essex, 1901, pp. 100, 101, the yield is given as 70,000 gallons a day in 1891; but successive dry years

Danbury, cont.

caused a continuous decrease, and the amount then yielded was barely sufficient for the requirements of the extended district.

According to the Water Works Directory, 1911, p. 82, the springs are from gravel, on the Common; the storage-capacity of the service-reservoirs is 128,000 gallons, and the amount supplied, in 1910, was 13,109,700 gallons; the population supplied was 4,000.

Dr. THRESH's Report of 1905 adds that springs and wells supply houses and farms not near the mains, and that about 20 cottages near Gay Bowers were dependent on rain-water.

For an analysis of the water, see p. 349.

Felsted.

Ordnance Maps 222, 223, new ser. (Essex 24, SE., 33, NE.).
Geologic Map 47.

Since 1901 a company provided a supply from a spring rising in a pond a little below the school, the water being raised to a tank on a tower.

The spring is protected by an iron cylinder, and was bought in 1912 by the Dunmow Rural District Council. The water is good. For an analysis, see p. 349. The yield is about 20,000 gallons a day.

Fingringhoe.

Ordnance Map 224, new ser. (Essex 37, NW.). Geologic Map 48, SW.

According to Dr. THRESH's Report of 1901, p. 134, a number of houses were supplied from a very excellent spring in the hollow below the school. It was protected, and a pump put up. Water was also taken from this to houses in Abberton and Langenhoe. There was another public spring.

Fryerning, see **Ingatestone.**

Great Baddow.

Ordnance Map 241, new ser. (Essex 53, NW., SW.). Geologic Map 1, NE.
Chiefly from Dr. THRESH's Report (Chelmsford R.D.C.) for 1911, pp. 15, 16, and plate, and from inspection.

The springs taken for public supply by the Chelmsford Rural District Council are close to the water-tower and about 1,330 yds. north-westward of the church, in a slight hollow. They come from the low flat of River Gravel.

According to Dr. THRESH's Report to the Authority for 1891 an average of 60,000 gallons was pumped daily. A later account gives the yield as from 70,000 to 90,000 (1903, J. DEWHIRST).

A slight change in the bacterial contents of the water, after heavy rain, led to tests being made, to trace the course of the water underground. The result was different from what had been expected, it being found that practically all the water, which comes from the south, enters the tank from the west. A bed of clay, in the gravel, which thins out northward, prevents impurities reaching the spring from the houses above the works.

Water is also got from Wells, see p. 166.

For an analysis of the water, see p. 349.

Great Bardfield.

Ordnance Maps 222, 223, new ser. (Essex 15, SE.). Geologic Map 47.

According to Dr. THRESH's Reports of 1901, p. 117 and of 1905, p. 59, the main part of the village was supplied from a public fountain, getting water from a spring on higher ground. In addition there were private wells and the supply generally was said to be good and abundant.

In 1912, however, the Medical Officer reported that many of the houses in the north of the village had no adequate supply and the generality of the wells were polluted with sewage.

Presumably all sources are from Drift Gravel.

Great Bentley.

Ordnance Map 224, new ser. (Essex 37 NE.). Geologic Map 48, SW.

Springs from the Drift Gravel have been taken (in a field a little NE. of the church), for the supply of Clacton, and part of the village is supplied

from stand-pipes connected with the mains. The water is filtered through sand. An analysis of the water is given on p. 350.

Several springs used to break out near the village, but the subsoil-wells sunk to supply Clacton have lowered the water-level, and the springs have ceased to flow.

Great and Little Waltham.

Ordnance Map 241, new ser. (Essex 43, NE.). Geologic Map 47.
Works for Chelmsford Rural District Council.
Water Works Directory, 1911, p. 83.

Springs from gravel (spring protected). Raised to a tank by a ram.

Population supplied about 300, the village-part of the two parishes.

For an analysis of the water from the Great Waltham springs, see p. 351.

Of *Great Waltham* Dr. Thresh says, in his Report of 1905, p. 46, that the hamlet of Ford End was supplied from a spring, piped to the roadside, and by a public pump; and that at North End a spring had been piped, to supply houses distant from the public well.

The spring used at Little Waltham rises in a field nearly opposite the school.

Hempstead.

Ordnance Map 205, new ser. (Essex 10, NW.). Geologic Map 47.

According to the Report of the Medical Officer for 1912 a public fountain in the village gets its supply from a spring and supplies about 37 houses. There is a public pump, also getting water from a spring.

Ingatestone and Fryerning.

Ordnance Map 240, new ser. (Essex 59, NE., 60, NW.) Geologic Map 1, NE.

According to Dr. Thresh's Report to the Chelmsford Rural Sanitary Authority for 1891, 1892, a supply for Ingatestone was got from springs at the edge of a small patch of gravel. The water contained a little clayey matter in suspension and so had to be treated; but the quality was not satisfactory. The supply was about 12,000 gallons a day. In the Report for 1893 it is said "At Ingatestone the water supply is derived from a chain of wells sunk in a bed of loamy sand."

According to J. Dewhirst and H. G. Keywood. *Trans. Brit. Assoc Water. Eng.*, 1903, vol. vii, p. 61, this supply, then of 14,000 gallons a day, was being abandoned, owing to pollution, and replaced by a deep well, see p. 200.

The spring-supply was started in 1884.

Laindon.

Ordnance Maps 257, 258, new ser. (Essex 68, SE., 76, NW.).
Geologic Map 1, SE.

Originally supplied by a local Company (to some extent at all events), the water being taken from springs on Laindon Hill, of which there are many (see p. 49). Now supplied by the Southend Water Co.

Lexden (for Colchester).

Ordnance Map 223, new ser. (Essex 27, SE.). Geologic Map 48, SW.
From J. M. Wood's paper, *Essex Naturalist*, 1912, vol. xvii, pp. 29, etc., to which enquirers are referred for further details.

"In or about 1905, the population of Colchester was still increasing and had already increased to such an extent that it was deemed prudent to look for a supplemental supply, as the demand was gradually overtaking the yield of the well (see p. 129), as the rest level was gradually falling, due to continuous pumping and a series of dry years. . ."

"As the present wells could not be touched . an entirely independent source had to be found, but there was not much necessity to search far, as the Lexden Gravel Springs were close at hand with the water in sight."

In 1888 a suggestion was made to use these (? by Mr. Wood). Analyses "revealed a rather large proportion of nitrates," and as "a certain prejudice existed . . against so-called surface springs containing nitrates," the springs were passed over, until, in 1902, "Dr. Thresh was consulted, when he was so impressed with their importance and the possibility of protecting them, that he reported most favourably on their adoption."

Lexden, cont.

The springs, by the foot of the southern slope of the valley of the Colne, "on the western boundary of the Borough . consist of a group of very strong gravel springs, which are thrown out to the surface by a junction of extensive sand and gravel beds with the London-clay. . . They unite to form a small stream . . . and had from time immemorial been the only motive power for driving Lexden Corn Mill."

The "gathering ground is a large plateau of gravel and sand to the south west," the area of which "is about 13 square miles, and the bed falls both toward the main valley of the Colne and the Roman river. The plateau rises to a maximum altitude of about 130 feet above O.D. The springs rise . . . at an elevation varying from 40 to 50 feet above O.D. to the south-west of the Malting Farm."

The water escapes from well--defined springs. The yield is considerable, even after abnormally dry periods; "in fact, the discharge has been looked upon in the neighbourhood for ages past as practically constant, but such is not quite the case, as it varies with wet and dry periods. The beds are of a porous nature, and of considerable thickness," therefore "a considerable portion of the rainfall percolates into the soil, and ultimately finds its way in the shape of springs into the valleys . . . especially at Lexden. The beds undoubtedly form a most efficient natural filter, as at the points of collection the formation is practically all clean sand, and even after heavy rain the water always comes away perfectly bright and clear; there is very little doubt that the beds form an underground reservoir of no mean capacity. The water is collected by cutting a trench in the water-bearing bed at right angles to the direction of the flow of the water, well at the back of each spring and below the level of the natural discharge or lip, and laying therein special perforated stoneware pipes, around which is packed shingle . . . each spring can be isolated and regulated, to discharge its natural yield; and in event of necessity arising, the underground reservoir can be drawn upon (by virtue of the collecting pipes being below the natural lips) for a time. . . ."

"The natural yield of the springs varies slightly . with wet and dry periods . . . there are no records of their yield previous to 1888." Gaugings made by Mr. Wood gave the following results, in gallons a day, "excluding the two eastern springs (close to the village), which have not been utilized. These, however, were approximately gauged and found to yield about 97,000 gallons," in September and October, 1888.

1888.	September and October	about	416,000
1902.	November, after a series of 3 dry years	,,	300,000
1903.	October 31st	,,	319,000
1905.	After the works were completed ...	nearly	350,000
1906.	Drawn from them from a short period ...	,,	500,000

"In order to thoroughly and efficiently protect the springs from pollution, an area of . . . 29½ acres of land has been acquired at the back of the springs in a south-westerly direction," which is the direction from which the underground water flows.

"Upon this land no manure or grazing of cattle is allowed. As an additional precaution, there is a second zone around each spring, enclosed with an unclimbable fence."

"In addition . . the springs are zealously guarded . and the water therefrom is examined periodically, both chemically and bacteriologically."

With this interesting paper there is a map, on a large scale, showing the springs, the collecting pits, the mains and the protective area.

Little Baddow.

Ordnance Map 241, new ser. Geologic Map 1, NE.

Most of the houses supplied from the Danbury works, the rest from springs and shallow wells.

Little Leighs.

Ordnance Map 241, new ser. (Essex 33, SE.). Geologic Map 47.

According to Dr. Thresh's Report of 1901, p. 103, there is no village. The Dog's Head Spring yields an abundant supply of good water to many cottages. The water must come from Drift Gravel.

Little Totham.

Ordnance Map 241, new ser. (Essex 45, SE.). Geologic Maps 1, NE., 47.

Dr. THRESH's Report of 1901, p. 110, says that the village was supplied by a capital spring, which is piped to the roadside. Outlying houses used shallow wells or brooks.

Little Yeldham.

Ordnance Map 206, new ser. (Essex 11, NE.). Geologic Map 47.

According to Dr. THRESH's Report of 1901 there was one public pump; but the chief supply was from two springs on private property.

The source is uncertain, the place being mapped as on Boulder Clay.

Maldon.

Ordnance Map 241, new ser. (Essex 54, NW.). Geologic Map 1, NE.

In the Second Report of the Medical Officer of the Privy Council, 1860, it is said that the supply was got from springs as well as from wells.

The Cromwell spring is well known, and its water is piped to the roadside on Cromwell Hill. It has recently (?1913) shown signs of pollution and a notice has been fixed up, warning people against using it. There are houses above it.

Margaretting.

Ordnance Map 240, new ser. (Essex 52, SW., 60, NW.). Geologic Map 1, NE.

Dr. THRESH's Report to the Chelmsford Rural District Council for 1895.

A supply has been taken from a spring at the bottom of the hill.

Messing.

Ordnance Maps 223, 241, new ser. (Essex 35, NE., SE.).
Geologic Maps 47, 48, SW.

Dr. J. W. COOK's Report for 1900, repeated in Dr. THRESH's Report of 1901, p. 135.

The village was chiefly supplied from a good spring, on higher ground, the water being piped to a central point. The source must be gravel.

There are springs in Pods Wood, which it has been suggested might be used.

Middleton.

Ordnance Map 206, new ser. (Essex 12, NE.). Geologic Map 47.

According to Dr. THRESH's Report of 1901, p. 139, this place is mainly supplied by two public wells, fed by a spring, and the water was pure when last analysed.

Notley, White and Black.

Ordnance Maps 241, 223, new ser. (Essex 34, NE. and S.E.).
Geologic Map 47.

According to Dr. THRESH's Report of 1905, p. 56, a supply is got from a spring (presumably from gravel) piped to a standpipe.

In like way the water from a spring has been piped to the roadside at Black Notley.

Roxwell.

Ordnance Map 240, new ser. (Essex 43, SW.). Geologic Map 1, NE.
Dr. THRESH's Report of 1901, p. 103.

The water from a spring of good water rising near the churchyard was carried by a pipe to the street. Some outlying houses could get water only from a brook, polluted by sewage from the village. In 1900 an outbreak of typhoid occurred amongst the consumers from this source.

Saffron Walden Rural District.

Springs furnish a part of the water-supply to the following villages: Bartlow End, Clavering, Elmdon and Strethall, as well as to others, noted elsewhere; but in each case the yield is very limited.

South Hanningfield.

Ordnance Map 258, new ser. (Essex 61, SW.). Geologic Map 1, NE.

According to Dr. THRESH's Report of 1901, p. 104, the village proper (a small group of houses) was supplied by a private pump at an inn, fed by a

spring. A few large houses depended on rain-water, and many cottages used brooks and ponds. There were two public dipping places, neither yielding good water.

Terling.

Ordnance Map 241, new ser. (Essex 34, SE., 44, NE.). Geologic Map 47.

According to Dr. THRESH's Report of 1901, p. 115, a satisfactory supply was then pumped from a well (spring) by a ram, to parts of the parish. A small part was supplied from a spring near the school.

The supply is now got from one of the springs which rise in the grounds of Terling Place, the water from which flows to a pump-well near the road and is forced into the mains.

The water must come from Drift Gravel.

Tilbury-juxta-Clare.

Ordnance Map 206, new ser. (Essex 11, NW., NE.). Geologic Map 47.

Dr. THRESH's Report of 1901, p. 121, says that there was a public spring near the church; but outlying parts used ponds and ditches.

Tiptree (in four parishes).

Ordnance Map 241, new ser. (Essex 45). Geologic Map 47.

Numerous springs break out at the edge of the irregular patch of gravel at Tiptree Heath. The best known is the spring at Tiptree Hall. This water is utilized by means of a ram for supplying the hall and farm-premises, and the overflow, which may be 20,000 or more gallons a day, flows into the Layer Brook. Another important spring rises in a patch of boggy ground at the back of Brook House at the edge of Inworth Parish. The ground was opened out near where the water was seen to rise and the flow gauged. All the water could not be collected, but it was found that over 15,000 gallons a day was available. A well was sunk just above the spring and the gravel found to be 24 feet thick and full of water to the level of the spring. The yield of the well, as tested by a fortnight's continuous pumping, was 18,000 gallons a day. A Canadian wind-mill and pump were placed over the well and the water raised to a small reservoir on ground sufficiently high to supply that part of the village which is in Tolleshunt Knights parish. When the demand for water increased observation showed that notwithstanding the pumping from the well the water-level at the spring had decreased but little. A second well was therefore sunk close to the spring and the water carried by means of a syphon to the pumping well. By this means the supply was greatly increased and has allowed of the mains being considerably extended. The works were completed in 1913. The examination of the site indicated that nearly a square mile of gravel might be drained by the spring.

For an analysis of the water, see p. 353.

Ulting.

Ordnance Map 241, new ser. (Essex 44, S.E.). Geologic Map 1, NE.

There is no village. The supply is chiefly from springs. One spring is piped to a small tank at the roadside and the water is drawn from a tap. One of the springs rises in a field near the church: another at the roadside near the school.

Upminster.

Ordnance Map 257, new ser. (Essex 75, NW.). Geologic Map 1, SW.

According to Dr. THRESH's Report of 1901, p. 69, a few houses (on the common) were using a spring. The water presumably came from high-level River Gravel.

West Hanningfield.

Ordnance Map 241, new ser. (Essex 61, NW.). Geologic Map I. NE.

Dr. THRESH, in his Report of 1901, p. 104, says that the small village then got water from a spring in a meadow, some way off. The quality was not unexceptionable. Outside the village water was difficult to get and was sometimes carted for miles. Roadside-brooks or ditches and ponds were in many cases the only source of supply.

Wickham Bishop.

Ordnance Map 241, new ser. (Essex 45, SW.). Geologic Map 47.

According to Dr. THRESH's Report of 1901, p. 112, the principal supply was then from a public dipping place, built over a spring. There were also private wells, some polluted.

Since then a pump has been placed over the spring, to render the water more accessible, and the spring has been enclosed and protected. The water must come from gravel.

Widdington.

Ordnance Map 222, new ser. (Essex 14, NW.). Geologic Map 47.

The Report of the Medical Officer for 1912 says that there is a public standpipe in the village, supplying about 51 houses, the water coming from a brick-reservoir, supplied from a spring

Witham.

Ordnance Map 241, new ser. (Essex 44, NE.). Geologic Map 47.

The water from springs in the little hollow northward of Blunts Hall, westward of the town, was taken for public supply (as late as 1901). There is black peaty soil in parts. According to Dr. THRESH's Report of 1901, p. 114, the yield in dry weather came to 52,000 gallons a day; but the land being highly cultivated the water must be regarded as liable to contamination. This supply has been abandoned.

Woodham Walter.

Ordnance Map 241, new ser. (Essex 53, NE.). Geologic Map 1, NE.

1. According to Dr. THRESH's Reports of 1901, p. 112, and of 1905, p. 43, springs are abundant. Water from some was piped into the village-street. There were many private wells, and a few houses got water from a brook. Some of the wells were unsafe.

The chief supply here, however, is the following, but the village does not use it.

2. Purleigh and District Waterworks. 1900.

Dr. J. C. THRESH. Report on the Water Supply of Essex, 1901, pp. 107, 108, and J. DEWHIRST and H. G. KEYWOOD, *Trans. Brit. Assoc. Water. Eng.*, 1903, vol. vii, pp. 54-61, pl. iv (map).

The parishes supplied are Althorne, Cold Norton, Hazeleigh, Latchingdon, North Frambridge, Purleigh, Stow Maries, and Woodham Mortimer. To these Mayland has since been added.

Before the establishment of these works many parts of the above area were without supply save from ponds and ditches. A number of farms had deep wells, averaging 300 ft. in depth, but made when boring was not well understood. The linings were of thin sheet iron and little care had been taken to keep out surface-water. The quality of the water had deteriorated and many of the wells had been closed. The water-level in the deep wells had been gradually sinking for years, and many did not yield enough. In many cases water had to be carted for a mile or more.

Five parishes were originally included in the scheme, with a population of only 1,604, scattered over more than 12,000 acres. Three others expressed a wish to join in, their water-supplies having failed. The eight parishes provided for had a population of 2,329, spread over nearly 20,000 acres.

The springs rise in pasture-land at the foot of a hill, some 100 ft. from the stream into which their water flowed. On the gravel-patch which feeds them there was only one house, nearly half a mile away. The four springs used yield 100,000 gallons of excellent water in a day (? more). To protect them 10 acres of ground were acquired. There is another large spring, not yet used.

The pumping station is near the springs, with the collecting reservoir in front, the service-reservoir being 1,200 yds. off.

A large proportion of the cottages and farms have been directly connected with the main.

These works show what can be done in a purely rural district with a small rateable value and a scattered population, and are an encouragement to other places in like circumstances to carry out like work.

The water is soft. For an analysis, see p. 353.

SUPPLIES FROM WELLS.

Geologically the wells of Essex may be roughly classified in three groups. Firstly are the many more or less shallow wells which get their water from the permeable members of the Drift, with which we may here include the patches of Bagshot Beds on some of the higher grounds. In some cases these wells are at places where the various sands and gravels are at the surface, in others they are sunk through Boulder Clay.

Secondly, come the deeper wells and borings which have been carried through the London Clay into the Lower London Tertiaries, from some of the sandy beds of which they get their water. There are many old wells of this sort, as formerly sands beneath the London Clay were the deepest source of water sought for.

Thirdly, we have the most important group, in which the well or boring has been carried through the Tertiary beds into the Chalk, as well as many through Drift into Chalk, and some in bare Chalk, besides a very few that go through the Chalk. In many cases the water of the deep borings seems, however, to come from the Lower Tertiary sands rather than direct from the Chalk; indirectly, however, it probably comes from the Chalk, as the area of outcrop of these Tertiary sands is small.

From another point of view our wells may be divided into public and private, the latter, of course, being greatly in numerical excess. Amongst the public supplies there are plenty under the control of councils, and companies are also well represented, including naturally (in the absence of any Water Board outside the metropolitan area) the works of widest extent.

Between the public and private works there is an intermediate set, consisting of wells which, while not supplying the public at large, are not used for a strictly private purpose. Many institutions of a more or less public character (such as hospitals, workhouses and schools), have their own supplies.

Of the private wells the chief ones are for trade-purposes, for the supply of manufactories of many sorts, especially in the metropolitan district, the thickly populated south-western part of the county.

By reference to the Index it will be seen how wide are the purposes of supply for which wells have been made.

As regards depths of borings for water Essex seems to take a high place, having no less than 79 which are 500 ft. or more deep, and these may be classed as follows:—

500 feet deep, but less than			600	...	35 (+4 in Addenda)
600	,,	,,	,, 700	...	12
700	,,	,,	,, 800	...	6
800	,,	,,	,, 900	...	10
900	,,	,,	,, 1,000	...	5
1,000	,,	,,	,, 1,100	...	5
1,100 feet and over	...		...	...	2

The following wells and borings for water are of geologic interest. Besides these, of course, there are very many giving important information as to the thickness of various geologic formations and, notably, as to the depth to the Chalk:—

Debden, No. 7. Shows a great thickness of Glacial Drift.
East Ham. The deep boring at Beckton Gasworks, carried through Tertiary and Cretaceous beds to Old Red Sandstone.
Great Warley, No. 2, for its great depth through Tertiary beds into Chalk.
Harwich, No. 6. Through Tertiary and Cretaceous beds to Old Rocks.
Ingatestone, shows the greatest thickness of London Clay yet recorded.
Littlebury, No. 2.
Newport, Nos. 2, 3. } Showing a Deep Channel of Drift in the Valley of the Cam.
Wendens Ambo.
Loughton, No. 2. Through Tertiary and Cretaceous beds down to the Gault.
Shoeburyness, for its great depth into the Chalk, through Tertiary beds.
Wickham Bishop, for giving evidence of duplication of Lower Tertiary beds, through a fold or fault.

The following wells are notable in regard to the supply of water:—

Those of the Metropolitan Water Board, at Barking, Lea Bridge, Waltham Abbey, Walthamstow, No. 5, 6, and Wanstead.

Those of the Southend Water Co. at Billericay, Bowers Gifford, Downham, Eastwood, Nos. 1-5, Fobbing, Nos. 3-7, Great Wakering, Pitsea, Prittlewell, Ramsden Bellhouse, South Benfleet, Southend, Thundersley, Vange, and Wickford.

Those of the South Essex Co. at Grays, Hornchurch, Ilford, Mucking, Romford.

Braintree, etc; Brightlingsea; Chelmsford, Nos. 11-13; Coggeshall; Colchester, No. 6; East Ham, Beckton, a number of wells; Frinton, Great Baddow; Halstead, Nos. 4, 5; Ingatestone; Maldon; Mistley; Mundon; Rowhedge; Walton; Witham, Nos. 6, 7.

Of the following wells I believe that no information has been published, or, at all events, no details. Besides these, many others of less importance, from shallowness, imperfection of record, etc., are also new:—

Abberton (three); Ardleigh, No. 5; Arkesden, Nos. 1, 4; Barking, No. 7; Berners Roding; Billericay (two); Birdbrook; Bocking, Nos. 3, 4; Bowers Gifford; Brentwood, No. 2; Broomfield; Burnham, No. 1; Canvey, Nos. 1, 3, 4; Chelmsford, Nos. 4, 5, 6, 9, 10, 12, 13; Chignal St. James; Clavering, No. 2; Coggeshall, No. 1; Colchester, Nos. 4, 5, 6, 8; Corringham, Nos. 4, 5; Dagenham, Nos. 3, 4; Debden, No. 7; Dedham, No. 5; Downham; Earls Colne, No. 3; Eastwood, Nos. 2, 3, 4, 5, 6, 7; Elsenham, Nos. 4, 5, 7; Fobbing, Nos. 1, 3-7; Foulness, No. 7; Foxearth, No. 2; Grays, No. 3; Great Bentley; Great Bromley; Great Dunmow, Nos. 2, 3; Great Hallingbury, No. 3; Great Wakering, Nos. 1, 3; Great Warley, No. 2; Hadleigh (two); Halstead, No. 6; Hatfield Peverel, No. 2; Heybridge, No. 5; Hockley; Hornchurch, No. 2; Horndon, No. 1; Ilford, Nos. 1, 3, 9, 11, 12, 13; Ingatestone, No. 2; Kirby le Soken (two); Laindon, No. 2; Laindon Hill, No. 2; Layer Marney (two); Lea Bridge, No. 2; Little Chesterford; Little Easton; Little Hallingbury, No. 2; Little Horkesley; Maldon, Nos. 1, 5, 7; Manuden, No. 2; Margaretting, No. 2; Markshall; Mistley, Nos. 1, 4; Mucking, Nos. 2, 3; Mundon, Nos. 1, 2; Nazeing, No. 2; Newport, Nos. 2, 4; Osea; Peldon; Pitsea, Nos. 1, 6; Quendon, Nos. 4, 5, 6; Radwinter, No. 3; Rainham, all seven; Ramsden Bellhouse; Rayleigh, No. 1; Rowhedge, No. 1; Roxwell, No. 5; Roydon, Nos. 4, 5; Saffron Walden, No. 4; Sheering, No. 4; Shoeburyness, Nos. 2, 5; Southchurch, No. 2; Southend, No. 1; Stanford le Hope, Nos. 6, 7, 8, 9; Stansted, Nos. 5, 6, 7, 8, 12 (Pennington Lane Boring); Stanway, No. 6; Stifford, No. 2; Stisted; Sturmer (two); Takely, Nos. 1, 5; Thundersley (two); Tilbury-juxta-Clare; Tollesbury, No. 3; Ugley, No. 2; Upminster, Nos. 1, 2; Vange, No. 3; Wallasea; Waltham Abbey, No. 4; West Mersea, No. 1; West Thurrock, Nos. 2, 3, 6; Wickford, No. 3; Wimbish; Witham, No. 7; Wivenhoe, No. 1; Wormingford; and North Woolwich, No. 2; and others in Addenda.

DETAILS OF WELLS AND OF BORINGS FOR WATER.

All known published records have been included in the following pages, further details being given in very many cases. To this printed matter, scattered through a large number of books and papers, including no less than seven Geological Survey Memoirs, much new material has been added. (*See* p. 84.) The whole has been arranged alphabetically, by places, that is to say, under the names of the towns or villages in which the wells occur. In this the nomenclature of the original has not always been followed, for, especially in old records, exact topography is often absent: indeed, one's own previous efforts have had to be corrected in this matter occasionally. Sometimes, of course, it is difficult to fix the site of an old well, the old observers were not blessed with detailed maps, such as those now supplied by the Ordnance Survey. Frequent cross-references however are given, and a reference to the Index may generally get the reader out of any place-difficulty.

Of the wells described many are small and unimportant; but it is inadvisable to neglect the shallowest work or the most summary account. Of course there must be an enormous number of small wells that remain unrecorded; but probably fair samples of all sorts are noticed in the following pages. Some old records seem to be of little value except as pointing to former conditions, notably, to overflow in places where it has ceased. Further records will be thankfully received by the authors.

Under the chief place-headings are noted the one-in. ordnance maps, the county 6 in. maps (at all events the chief ones), and the geological maps of the places.

[Words in these brackets in the accounts of sections have been inserted by W. W.]

Abberton.

Ordnance Map 224, new ser. (Essex 36, NE., SE.). Geologic Map 48, SW.

1. Abberton Hall. (House on the newer map.) 800 yds. NE. of the Church; nearly opposite Abberton Manor.

Made and communicated by H. C. SMITH.

Water-level 110 ft. down.

Yield 600 to 1,000 gallons an hour by hand-pump.

		Thickness. Ft.	Depth. Ft.
Dug well (old) the rest bored ...		—	60
[London Clay]	Clay	110	170
	Sandy clay ...	30	200
[Reading Beds]	Mottled clay ...	40	240
	Dark green sand	15	255
	Coloured sands	18	273
	Flints	1	274
[Upper] Chalk		130	404

For analysis of the water, see p. 354.

2, 3. Pantile Farm, Peldon Road.

Two Borings made and communicated by H. C. SMITH.

One (the earlier) a 6-in. bore, near the 50-ft. contour-line.

Water-level $36\frac{1}{2}$ ft. down.

Abberton, cont.

Dr. Cook says pumping for some days at 6,000 gallons an hour only reduced the water-level $5\frac{1}{2}$ ft.

To base of London Clay	125	326 ft.
Lower London Tertiaries	101	
Chalk	100	

The second (midway between Abberton and Geldon).
Water-level 37 ft. down.
Yield. Tested by hand-pump up to 1,000 gallons an hour.

		Thickness. Ft.	Depth. Ft.
[London Clay]	Yellow clay ...	15	15
	London clay ...	97	112
	Rock	$1\frac{1}{2}$	$113\frac{1}{2}$
	Sandy clay ...	$6\frac{1}{2}$	120
	Rock	1	121
[? Oldhaven Beds]	Grey sand ...	9	130

The water has a lot of grey sand in suspension (2nd Nov., 1911).
For analysis of the water from these two wells, see p. 354.

According to Dr. J. W. Cook's Report for 1900, repeated in Dr. Thresh's Report of 1901, p. 132, there were shallow wells in Abberton, but the village was very badly off for water, which was carted from a spring at a distance (Fingringhoe) and sold at a halfpenny a pail.

Abridge, see Lambourne.

Aldham.

Ordnance Map 223, new ser., but not marked thereon. Geologic Map 48, SW.
Dr. J. W. Cook's Report of 1900, repeated in Dr. Thresh's Report of 1901, p. 132.
Supplied wholly from shallow wells, not always desirably placed.

Alresford.

Ordnance Map 224, new ser. (Essex 37, NE.). Geologic Map 48, SW.
Dr. Thresh's Report on the Water Supply of Essex, 1901, p. 124.
The parish was chiefly supplied by shallow wells, averaging 12 ft. deep. Two attempts to drive tube-wells failed, owing to a kind of ironstone (iron-pan) which stopped the spike.

Althorne.

Ordnance Map 258, new ser. (Essex 62, SE.). Geologic Map 2.

1. Great Eastern Railway Station. N. of line and 100 yds. W. of road. 1888.

Communicated by W. T. Foxlee, late Resident Engineer, Essex Lines, and from Messrs. Le Grand and Sutcliff.
Original surface 19 ft. above Ordnance Datum. Now filled up 5 ft. higher.
Shaft 16 ft. (from filled in surface), the rest bored.
Water rose to within 21 ft. of new surface, at the rate of 2 gallons a minute

			Thickness. Ft.	In.	Depth. Ft.	In.
Made ground (added above original surface)			5	0	5	0
[London Clay.]	Brown clay		34	0	39	0
	Blue clay		274	0	313	0
	Sandy clay		18	0	331	0
	[Basement-bed.]	Sand and shells ...	2	6	333	6
		Stone		10	334	4
		Clay and sand, with a few black [flint] pebbles	8	8	343	0
[Reading Beds.]	Running sand		3	0	346	0

For analysis of the water, see p. 355. Not used. Excessively hard (J. C. T., May, 1909).

Althorne, cont.

2. Summerhill, on the side of the hill just below the Church on the Latchington Road. There is a well here said to be sunk through the London Clay to the sands beneath. For analysis of the water, see p. 355.

3. Bridgemarsh, an island in the Crouch. Old well.
Information from Mr. PURKIS, the sinker, to W. H. DALTON.

Alluvium, etc.	40	310 ft.
London Clay, to sand ...	270	

When Dr. THRESH saw this well, a few years ago, the water rose and fell with the tide. It was very brackish, and not used.

The parish was once badly supplied from wells and ponds. It is now served by the Purleigh Waterworks (see p. 82).

Ardleigh.

Ordnance Map 224, new ser. (Essex 19, SW., SE., 28, NW., NE.).
Geologic Maps 48, NW. and SW.

1. 1½ miles towards Colchester, nearly level with the kilnyard.
Rev. W. B. CLARKE.—*Trans. Geol. Soc.*, ser. 2, vol. v, p. 269.

Red clay	20	110 ft.
Blue clay, with oysters at the depth of 105 ft.	90	To sand and water.

2. House at entrance to brickyard about 2 miles NE. from Colchester, about 1873.
Information given by Mr. MANN, well-sinker.
250 ft. of [London] Clay. No water.

3. Merchants Cottages, on the western side of the road south of the Church. Shallow well, 9½ ft. to water. October, 1897.

4. Mill House (Phoenix Mill). Western side of the road north of the Station. Boring to London Clay, through soil, gravel and sand, 25 ft.

There is also a well here.

For analyses, to show the passage of underground water, see p. 355.

5. Holfdene, Mr. Wilson's. 1908.
Boring. Information from D. J. W. COOK.
Water rose to 105 ft. from the surface.

To Chalk ...	235	290 ft.
Chalk ...	55	

According to Dr. THRESH's Report on the Water Supply of Essex; 1901, pp. 124, 125, the usual supply was from shallow wells, some 20 ft. deep, some very shallow.

In one well (not one of the above) large concrete tubes were used, and 16 ft. down a hard crust of iron-pan was found, not more than an inch thick, and beneath it white sand with much water, so much that the well could not be sunk deeper than 18ft. The water, at first of good quality, became contaminated owing to imperfect lining.

Ardleigh is now in the area of the Tendring Hundred Co., and the mains (from Dedham) will shortly be laid through the village.

Arkesden.

Ordnance Map 222, new ser. (Essex 8, SE.) Geologic Map 47.

1. Chardwell Farm, westward of the village.
Two wells, communicated by Mr. FEATHERBY.
a. At the farm. 380 ft. above Ordnance Datum.
Boulder Clay, 30 ft. No water.
b. 5 chains NW. of the farm. Apparently the site of a former pond 390 ft. above Ordnance Datum. Water got.

Bog with thin layers of sand ...	5	11 ft.
Black mud with bits of timber ...	6	

Arkesden, cont.

2. Little Beckets Farm. 1871.
Made and communicated by Mr. G. Ingold.
Water at 116 ft.

To Chalk ... } 126 ft.
In Chalk ... }

3. Public Well. 1877.
Made and communicated by Mr. G. Ingold.
Water-level 69 ft. down.

Gravel and clay [Boulder Clay] ... 35 } 72 ft.
Chalk ... ... 37 }

? Deepened to 84 ft. (see Dr. Thresh's Report of 1905, p. 61).

4. Woodhall. SSW. of the Church. 1898.
Made and communicated by Mr. G. Ingold.
Shaft 167 ft., the rest bored.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift. Boulder Clay, etc.]	Brown clay	3	3
	Yellow sandy loam with water ...	3	6
	Brown clay	12	18
	Blue clay	79	97
	Sandy loam, brown clay	8	105
Chalk ...	... ...	102	267

Ashdon.

Ordnance Map 205, new ser. (Essex 3, SE.). Geologic Map 47.
New House Farm. 1891.
Made and communicated by Mr. G. Ingold.
Water-level 54 ft. down.

			Thickness. Ft.	Depth Ft.
[Glacial Drift.]	[Boulder Clay.]	Brown clay ...	12	12
		Blue clay ...	42	54
	Gravel		3	57

According to the Report of the Medical Officer (W. Armistead) for 1912, there are two public pumps, one from a well into the Chalk, $60\frac{1}{2}$ ft. deep, the other from a spring.

Asheldean (? mistake for **Asheldham**).

Rectory. Old well. Information from Mr. Purkis, the sinker, to W. H. Dalton.
Gravel, to London Clay, $14\frac{1}{2}$ ft.

Asheldham.

Ordnance Map 241, new ser. (Essex 63, NE.). Geologic Map 2.
According to Dr. Thresh's Report of 1901, p. 109, water was got from a public roadside-pump, and was of excellent quality. Many scattered houses depended on a brook or pond.
The supply is now taken from the Southminster Works, see p. 73.

Ashingdon.

Ordnance Map 258, new ser., but not marked thereon (Essex 70, NW.).
Geologic Map, 1, NE.
Old well. Information from Mr. Purkis, the sinker, to W. H. Dalton.

London Clay ... 320 } 360 ft.
Sand, to water ... 40 }

According to Dr. Thresh's Report on the Water Supply of Essex, 1901, p. 78, there was no public well. There is a boring at the Hall and a deep well at Hill Farm (? the above). Most other houses depend on rain-water. The supply of the parish was deficient in quality and quantity. No change mentioned in the Report of 1905.

Audley End, see Wenden.

Aveley.

Ordnance Maps, 257, 271, new ser. (Essex 83, NW.). Geologic Map 1, SW., and London District, Sheet 4.

Aveley Hall. Marshfoot Farm. Within 100 yds. of the house. 1835.
Dr. J. MITCHELL'S MSS., vol. ii, p. 115, and vol. iii, p. 86.
Water rose to the surface. Yield 15 gallons a minute. (1835.)

	Thickness. Ft.	Depth. Ft.
A little vegetable mould, and moor bog	20	20
Gravel and sand, with a little yellow clay ...	50	70
[Upper] Chalk	37	107

Mr. THOMAS, of Aveley Hall, says it is 270 ft. deep, and that the water is pumped into a ditch for the use of cattle.

For analysis of water, see p. 356.

According to Dr. THRESH'S Report of 1905, 95 per cent. of the population was supplied by the South Essex Water Co., and the rest from private wells.

Aythorpe Roding.

Ordnance Map 240, new ser. (Essex 32, SE.). Geologic Map 47.

According to Dr. THRESH'S Report of 1901, p. 117, the houses, about 60 in number, were supplied by 13 private wells (presumably through Boulder Clay to gravel).

Baddow, see Great Baddow.

Bardfield Saling (see Little Saling of the old map).

Ordnance Maps 222, 223, new ser. (Essex 24, NE.). Geologic Map 47.

According to Dr. THRESH'S Report of 1901, p. 117, water was got from two public wells (presumably through Boulder Clay to gravel or sand). There are also private wells.

Barking.

Ordnance Map 257, new ser. (Essex 73, SE., 74, SW.). Geologic Maps 1, SW., and London District, Sheet 2.

According to W. RANGER'S Report to the General Board of Health, 1854, there were then no waterworks. " The inhabitants, therefore, procure what they require from pumps and wells on their own premises, or if they have no such supply, they buy water from carriers, who retail it at the rate of three gallons for a farthing"; and we are told that "many of the wells are so shallow that they go dry in hot weather." There were, however, two public pumps, one often dry. " The shallow wells generally went down into the gravel about 14 ft."

Even then, however, deep-seated springs were bored down to, about 200 ft., into sand, and one well had been carried down into the Chalk, the water rising to within 10 ft. of the surface.

1. Barking Mills, within 30 yds. of the Roding. 1875.
Communicated by W. BEWERS.
Bored throughout, with an 11-in. pipe into the Chalk.
Water rose to within 16 ft. of the surface.
Yield about 30 gallons a minute.

		Thickness. Ft.	Depth. Ft.
Made soil [? in part Alluvium]		12	12
[Alluvium or River Drift ?] Sandy clay		5	17
[River Drift.] Sand and running gravel		4	21
[London Clay] 39 ft.	Blue clay	16	37
	Sand	1	38
	London clay	18	56
	[? Basement-bed]. Shells, pebbles and green sand	4	60

Barking, cont.

		Thickness. Ft.	Depth. Ft.
[Woolwich Beds] 49 ft.	Shells	2	62
	Hard shells, flint and pebbles ...	9	71
	London clay, sand and shells	12	83
	Yellow clay and white sand	7	90
	White sand	6	96
	[Bottom-bed.] Pebbles, green and black sand and large stones	9	105
	[Bottom-bed.] Pebbles, sand and rock over water	4	109
Spring [Thanet] sand		52	161
[Upper] Chalk		235	396

Water classed as first class, by G. W. Wigner, who analysed it in 1878, see p. 357.

2. Byfrons.

140 ft. deep, the bottom part in hard pebble-beds [Blackheath Beds, or bottom of the Woolwich Beds].

Water within 30 ft. of the ground.

3. East London Waterworks, now Metropolitan Water Board, half a mile from the western side of the town, just east of the Roding, and close to the main road. 1896. Apparently known as the East Ham Well, though in Barking.

Communicated by W. B. Bryan, Engineer to the Company.

About 12 ft. above Ordnance Datum. Shaft throughout.

		Thickness. Ft.	Depth. Ft.
Soil	... ...	2	2
[River Drift] 17½ ft.	Loamy clay	5	7
	Hard gravel	5	12
	Cleaner gravel ... ... over	7½	19½
[London] Clay	... ...	21	40½
[? Basement-bed of London Clay, or partly Woolwich Beds ?]	Shells (? about 4 inches) ... over	—	40½
	Very dark soft sand ... ... nearly	1½	42
	Sandstone rock ... ... ,,	1½	43½
	Very dark soft sand	1¼	44¾
	Two-inch layers of sand, clay, pebbles, and shells	2¾	47½
	Soft clay and shells	1½	49
	Hard shell-rock	¾	49¾
[Woolwich Beds] 34¼ ft.	Shelly dark green sand	8¼	58
	Very hard dark clay, with shells ...	6	64
	Loamy sand ... ... over	3	67
	Light-grey sand ... ... nearly	5½	72½
	Dark sand	5½	78
	Clay and sand	3½	81½
	Loamy sand and black [flint] pebbles	2½	84
[? Woolwich Beds or Thanet Sand.]	Dark grey sand ... ... nearly	19	103
	Dark sand and pebbles	5	108
[Thanet Sand, 33 ft.]	Dark grey sands, with a harder vein from below 114 to 116 ft.	20½	128½
	Harder dark grey sands	12	140½
	Green-coated flints	½	141
Chalk, with 10 ins. of flints, below 147 ft.; 6 ins., below 148; 4 ins., below 153½; a foot, below 173½, 177, and 181½; 6 ins., below 184; 9 ins., below 189½; 6 ins., below 198; a foot, below 199½; and 6 ins., below 205½ and 207½		68½	209½

As will be seen, there is some difficulty in fixing the divisions of the Eocene formations, and this was also the case in regard to the well at Glenny's Brewery. For analyses of the water, see p. 356.

Barking, cont.

4. Glenny's Brewery. 1889.

Made and communicated by Messrs. Le Grand and Sutcliff.

Water-level 17 ft. down. (1889.) Fell suddenly to 62½ ft. on the opening of the East London Co.'s Well.

			Thickness. Ft.	In.	Depth. Ft.	In.
Dug well (the rest bored) ...			—		10	0
[River Drift] gravel ...			12	0	22	0
[London Clay]	Red clay ...		1	0	23	0
	Blue clay ...		42	0	65	0
	[? Basement bed.]	Conglomerate, clay, stone, and shells ...	1	6	66	6
		Hard rock ...	0	5	66	11
		Sand, clay and pebbles	3	0	69	11
		Rock, flints, and shells	0	7	70	6
[Woolwich and Reading Beds.]	Loam and shells ...		1	6	72	0
	Sand and shells ...		6	0	78	0
	Blue clay and shells ...		11	0	89	0
	Rough pebbles ...		0	6	89	6
	Mottled clay and sand ...		16	6	106	0
	Dark clay and sand ...		2	0	108	0
	Black pebbles ...		0	6	108	6
	Dark sand, clay, and pebbles ...		17	6	126	0
[Thanet Sand, 40 ft.]	Thanet Sand ...		33	0	159	0
	Dead sand ...		6	6	165	6
	Flints ...		0	6	166	0
[Upper] Chalk and flints ...			154	0	320	0

There is a difficulty in fixing the base of the London Clay, and perhaps the lowest bed classed with the Woolwich Series, may belong in part to the Thanet Sand. An analysis of the water is on p. 357.

5. White's Mineral Water Works, Axe Street. 1887.

Communicated by W. Bewers, of Barking Mills (? St. Anne's), and by Messrs. Le Grand and Sutcliff.

Water-level about 24½ ft. down.

			Thickness. Ft.	Depth. Ft.
Dug well [? gravel], the rest bored ...			—	10
[River] Gravel ...			20	30
[London Clay 57 ft.]	Blue clay ...		25	55
	Loamy blue clay ...		21½	76½
	Hard clay ½ and then claystone 1 ...		1½	78
	Loamy blue clay ...		2	80
	[? Basement bed.]	Fine running sand ...	3	83
		Black [flint] pebbles...	3	86
		Gravel [pebbles ?] ...	1	87
[Woolwich and Reading Beds 44 ft.]	Blue clay and shells ...		1	88
	Shells and conglomerate ...		2	90
	Blue clay and shells ...		10½	100½
	Clay, sand and shells ...		1	101½
	Clay and sand ...		2	103½
	Mottled clay and dark sand ...		3½	107
	Mottled clay and light-coloured sand		2	109
	Dark green sand ...		4	113
	Sandy clay ...		8	121
	Pebbles ...		½	121½
	Sand and pebbles ...		2	123½
	Sand ...		6½	130
	Sand and pebbles ...		1	131
Thanet Sand, blowing ...			51½	182½
Chalk, 400½ ft.	White chalk and flints ...		236½	419
	Grey chalk and flints ...		91	510
	Hard, grey chalk, sticky at times ...		73	583

For analysis of the water, see p. 357.

Barking, cont.

6. Dr. J. MITCHELL'S MSS., vol. iii, p. 85.
Through blue clay to sand and pebbles, with water, 57 ft.

7. Barking Creek. Lawes' Manure Works. On the marsh, close to the Thames.
Bored some 30 years ago (note of 1898).
Water-level 10–15 ft. down at first; now (1898) about 20 ft.
Yield (1898) a few thousand gallons a day.
London Clay said to be only 6 ft. thick.
Chalk reached at 82 ft.
Boring taken to 200 ft.

At a recent gauging the depth was found to be only 145 ft. deep and there was much sand at the bottom; the boring is believed to be silting up. Apparently only a 3-in. bore. For an analysis of the water, see p. 357.

For details of the following wells (8–13), see Memoir on London Wells, by G. BARROW, 1912, pp. 91–93. In some cases the classification differs:—

8. Abbey Mill. Messrs. Warne's. 1897.
15 ft. above Ordnance Datum.
Shaft 70 ft., the rest bored.
Water-level 42 ft. below O.D. Yield 335,000 gallons a day.

	Thickness. Ft.	Depth. Ft.
Alluvium, 7 ft. and gravel 12 ft. ...	19	19
London Clay...	25	44
Woolwich Beds and Thanet Sand...	97	141
Upper Chalk	257	398

9. Jenkins Lane. Messrs. Gross & Co., Varnish Works. 1906.
10 ft. above Ordnance Datum.
Water-level 10 ft. below O.D. Supply 250 gallons an hour.

	Thickness. Ft.	Depth. Ft.
Alluvium, 8 ft. and River Gravel 25 ft. ...	33	33
London Clay...	46	79
Oldhaven Beds (13?) and Woolwich Beds	22	101

10. Messrs. Gross & Co. Second Boring. 1910.
Water-level 65 ft. below Ordnance Datum.
Supply tested to 3,000 gallons an hour.

	Thickness. Ft.	Depth. Ft.
Made ground and River Drift ...	27	27
London Clay...	56	83
Woolwich Beds and Thanet Sand...	102	185
Upper Chalk	222	407 (? since deepened to 450 ft.)

For analysis of the water, see p. 357.

11. Gas Works. 1910.
12 ft. above Ordnance Datum.
Water-level 60 ft. below O.D. Supply 5,000 gallons an hour.

	Thickness. Ft.	Depth. Ft.
Made ground and River Drift ...	27	27
London Clay...	56	83
Woolwich Beds and Thanet Sand...	102	185
Upper Chalk	199	404

Barking, cont.

12. Barking Creek. British Coalite Co. 1910.
5 ft. above Ordnance Datum.
Water-level nearly at O.D.

	Thickness. Ft.	Depth. In.
Alluvium 14 ft., and Rivel Gravel 30 ft. ...	44	44
Woolwich Beds and Thanet Sand...	91	135
Upper Chalk	105	240

13. Creekmouth. E. side. De Pass' Guano Works. 1894.
6 ft. above Ordnance Datum.
Water-level 55 ft. below O.D. Yield abundant.

Alluvium and River Gravel	46	200 ft.
Upper Chalk	154	

[The following are additional particulars:—Apparently a 3-in boring. Plenty of water at 200 ft., but brackish. Boring continued to 400 ft., when the water was pronounced good. A new well 143 ft. deep was bored in 1912. For analysis of the water of both, see p. 357.]

Barkingside, see **Ilford.**

Barling.

Ordnance Map 258, new ser. (Essex 71, SW., 79, NW.). Geologic Map 2.

According to Dr. Thresh's Report of 1901, p. 78, a very limited supply was got, wholly from shallow wells. The same holds in the report of 1905.

Barnston.

Ordnance Maps 222, 240, new ser. (Essex 33, NW.). Geologic Map 47.

According to Dr. Thresh's Report of 1901, p. 117, there was a public fountain, fed from a spring on higher ground. Also ten wells.

Basildon.

Ordnance Map 258, new ser., the name does not appear as a parish on this map. (Essex 68, SE.). Geologic Map 1, SE.

According to Dr. Thresh's Report on the Water Supply of Essex, 1901, p. 82, a deep well at the Vicarage gave the village-supply. Rain-water was collected for a subsidiary supply.

Lately included in the area of the Southend Water Co.

Battlebridge, see **Rettenden.**

Beaumont.

Ordnance Map 224, new ser. (Essex 30, SW., the village in 29, SE.). Geologic Map 48, SE.

According to Dr. Thresh's Report of 1905 the parish was badly off for water. There were wells, some of considerable depth; but generally speaking the supply was unsatisfactory. Many people had to cart water some distance.

It is now in the area of the Tendring Hundred Water Co.

Bramble Island. Enclosed Land westward of Pewit Island. 1880.
Sunk and communicated by T. Tilley.
Water rises to the surface. Large yield, but brackish.

		Thickness. Ft.	In.	Depth. Ft.	In.
[? Alluvium and London Clay.]	Dark clay	13	10	13	10
	Blue clay	17	8	31	6
	Clayey sand	3	6	35	0
	Blue clay	16	6	57	6
	Brown clay	18	6	70	0
	Brown sandy clay ...	8	0	78	0
[Reading Beds 37¼ ft.]	Coloured clay	15	0	93	0
	Loamy sand	5	0	98	0
	Coloured sandy clay ...	5	0	103	0
	Mottled clay	12	0	115	0
	Flints	0	3	115	3
[Upper.]	Chalk and flints	48	3	163	6

Beckton, see **East Ham.**

Belchamps, The.

Ordnance Map 206, new ser. (Essex 5, SE., 6, SW., 12, NW.).
Geologic Map 47.

Belchamp Otton, or *Otten.* Several private wells, two of which do not give an adequate supply. Ponds and ditches used. The water from one pond, near the schools, is filtered.

Belchamp St. Paul. Greater number of houses supplied by three public wells, one sunk into the Chalk and yielding good water, the other two in gravel and yielding a good supply of pure water.

Belchamp Walter. Most of the supply got from shallow wells and springs, and of good quality. Ponds, etc., used.

Benfleet, see **North** and **South Benfleet.**

Bentley, see **Great Bentley.**

Berden (Bearden on the old Ordnance Map).

Ordnance Map 222, new ser. (Essex 13, SW.). Geologic Map 47.

The Hall. 1884.
Made and communicated by Mr. G. INGOLD.
Water 122 ft. down.

			Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	[? Boulder Clay.]	Brown clay	5	5
		Sandy loam	1	6
		Blue clay	14	20
		Brown clay	1	21
	Chalky gravel		9	30
	Brown clay		12	42
	Hard chalky gravel		2	44
Chalk. Bed of flints at 92 ft. Many shells at 100 ft.			78	122

According to Dr. THRESH's Report of 1905, p. 51, the place is fairly well supplied from wells into Chalk, from 90 to 120 ft. deep; and nearly all were deepened a few feet in recent years.

Berechurch (or West Donyland).

Ordnance Map 224, new ser. (Essex 36, NE.). Geologic Map 48, SW.

Old Heath Brewery (Messrs. Cuddon's), SE. of Colchester. 1887?
Made and communicated by Messrs. ISLER & Co.
Pit of 8 ft., the rest bored, and tubed for 190 ft. (4-in. tubes).
Water-level 50 ft. down. Supply very plentiful.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Yellow clay	8	8
	Blue clay	82	90
	Dead dark sand and clay [? basement-bed]	8	98
[Reading Beds, 87 ft.]	Mottled clay	33	131
	Black sand-rock	2	133
	Dead green sand	11	144
	Black sand and clay	31	175
	Dark blue sand	10	185
[Upper] Chalk	... ...	51	236

Bergholt, see **West Bergholt.**

Berners Roding or Roothing.

Ordnance Map 240, new ser. (Essex 42, SE.). Geologic Map 47.

1. Berners Hall. See under analyses, p. 358.

2. Parsonage Farm, Berners Hall.
Communicated by H. O. N. SHAW, of Skreens Park.
226 ft. above Ordnance Datum.
Rest-level of water 106 ft. down. Excellent supply.

		Thickness. Ft.	Depth. Ft.
	Well (old) the rest bored ...	—	100
[? Boulder Clay.]	Blue clay and chalk ...	20	120
[London Clay.]	Blue clay with 5 layers of rock, each about 8 ins. thick. ...	140	260
[Lower London Tertiaries.]	Dark green sand ...	1	261
	Coloured sands ...	10	271
	Strong red clay ...	9	280
	Green sands ...	5	285
	Grey and green sand ...	35	320

Billericay (in the parish of Great Burstead).

Ordnance Maps 257, 258, new ser. (Essex 68, NW., NE.).
Geologic Map 1, NE.

1. Slice's Gate. $1\frac{1}{4}$ miles SE. of Billericay Church. Boring. For the Billericay Rural District Council. 1904.
Made and communicated by Messrs. MERRYWEATHER.
125 ft. above Ordnance Datum.

A test was made for a fortnight and the yield was 108,000 gallons in 24 hours, the level of the water being about 100 ft. down. Highest water-level (? since 1908) $97\frac{1}{2}$ feet down. Lowest (pumping) $318\frac{1}{2}$.
515 ft. of 12-in. tubes from 6 in. down.

		Thickness. Ft.	Depth. Ft.
	Soil ...	1	1
	Gravel ...	7	8
[London Clay, 352 ft.]	Clay (Red) ...	15	23
	Grey clay ...	320	343
	Sandy clay ...	17	360
[? Blackheath Beds.]	Sand and pebbles ...	15	375
[Woolwich Beds, 29 ft.]	Dark sand ...	2	377
	Light-coloured sand ...	6	383
	Green sand and [flint] pebbles	21	404
[? Thanet Beds.]	Fine loamy sand ...	$94\frac{1}{2}$	$498\frac{1}{2}$
	Flints and greenish sand ...	1	$499\frac{1}{2}$
[Upper Chalk.]	Chalk and flints... ...	$260\frac{1}{2}$	760
	Grey chalk ...	140	900

It is doubful whether it is right to class so great a thickness as Thanet Beds.

Taken over by the Southend Water Co. in 1908 (as No. 19 or Slice's Gate Bore). An account, from E. C. BILHAM, makes no mention of gravel.

Water from the sands of the Lower London Tertiaries. Little, if any, from the Chalk. For an analysis of the water, see p. 359.

2. Southend Water Co.'s No. 21 or Slice's Gate Main Well. 160 ft. NE. of Slice's Gate Bore. 1910.
Communicated by E. C. BILHAM, Engineer to the Company.
124 ft. above Ordnance Datum.
Sunk portion $333\frac{1}{2}$; 45-in. pipes to 358 ft. 10 ins., rest 24-in. unlined.
Highest water-level 135·5 ft. down. Lowest (pumping) $333\frac{1}{2}$.

Billericay, cont.

		Thickness. Ft.	Depth. Ft.
Soil		1	1
Brick-earth and gravel		6	7
[London Clay.]	Jointy clay	8	15
	Clay, more solid	8	23
	London clay; jointy at 233¾, very hard from 259 to 264 feet	332	355
[Lower London Tertiaries.]	Hard sand	5	360
	Softer sand	2½	362½
	" darker	6½	369
	Chocolate-coloured sand	4½	373½
	Softer and lighter sand	4	377½
	Dark green sand	22½	400

Water from sands of the Lower London Tertiaries.

Billericay Rural District.

Dr. Thresh, in his Report on the Water Supplies to the Rural Districts, says that it is a very difficult district to supply with water; but the difficulties were being gradually overcome. "The help afforded by the Southend Water Co. is much appreciated, as they have far exceeded their legal obligation."

Birch, Great and Little. Birch, of the older map.

Ordnance Map 223, new ser. (Essex 36, NW., SW.). Geologic Map 48, SW. Dr. J. W. Cook's Report for 1900, repeated in Dr. Thresh's Report of 1901.

Shallow wells were the usual source of supply, except at Birch Hall (spring). New wells have since been made, with concrete tubes.

Birchanger.

Ordnance Map 222, new ser. (Essex 22, SE.). Geologic Map 47.

1.—Blacklands. 1895.
Made and communicated by Mr. G. Ingold.

		Ft.	
Brown clay, with large flints [? Boulder Clay]		9	57 ft.
London Clay.	Brown clay	4	
	Dark slate-coloured clay	44	

2. Mr. Maitland's Cottages. Near the railway. 1887.
Made and communicated by Mr. G. Ingold.
Water-level 28½ ft. down.

		Thickness. Ft.	Depth. Ft.
Mould		1	1
[Drift.]	Loamy gravel	7	8
	Gravel and chalk	6	14
Soft white chalk		20	34

3. Public Well. The Green.
Sunk and communicated by Mr. G. Ingold. Shaft.

	Ft.	
Boulder Clay	20	67 ft
London Clay, sandy at bottom, with water	47	

? deepened since.

According to Dr. Thresh's Report of 1905, p. 51, isolated cottages get a supply from wells at farms, and about 25 new cottages at the north-western end of the village got water from wells from 20 to 30 ft. deep.

Birdbrook.

Ordnance Map 206, new ser. (Essex 4, SE., 10, NE.). Geologic Map 47.

1. Bailey Hill Farm. 1900.
Made and communicated by Mr. H. G. Featherby.

Birdbrook, cont.

Shaft 5 ft. diameter in the clear for 30 ft., then $4\frac{1}{4}$ for further 34 ft., steined with $4\frac{1}{2}$ in. of dry brickwork. Borehole 5 in., reduced to 4. Tubes to $136\frac{1}{2}$ ft. down.

Rest-level of water in Sept., 1900, $146\frac{1}{2}$ ft. down.

		Thickness. Ft.	Depth. Ft.
Top mould	...	1	1
[London Clay?]	Brown clay ...	9	10
	Blue clay ...	15	25
	Blue sand ...	$\frac{1}{2}$	$25\frac{1}{2}$
	Blue clay and sand ...	5	$30\frac{1}{2}$
	Blue clay ...	$14\frac{1}{2}$	45
	Brown loamy clay and sand ...	3	48
	Black sand and clay ...	4	52
	Blue sand and clay ...	12	64
	Blue clay ...	5	69
[Reading Beds.]	Loamy sand ...	21	90
	Red sand ...	$\frac{1}{4}$	$90\frac{1}{4}$
	Gravel ...	$28\frac{3}{4}$	119
	Red sand ...	8	127
[Upper.] Chalk	...	5	132
		62	194

2. Public well. Near Birdbrook Hall.
304 ft. above Ordnance Datum.
Shaft 96 ft., the rest bored.
Water-level 217 ft. above Ordnance Datum.

Boulder Clay ...	93	113 ft.
Sand, over Chalk ...	20	

There is another public well near the Rectory.

3. Finkle Green.
326 ft. above Ordnance Datum.
Water-level 219 ft. above Ordnance Datum.

	Thickness. Ft.	Depth. Ft.
Boulder clay	75	75
Sand without water ...	10	85
Brown clay	5	90
Sand and clay	11	101
Running sand	17	118

There are other private wells.

Blackmore.

Ordnance Map 240, new ser. (Essex 51, SE.). Geologic Map 1, NW.
Largely supplied by a shallow public well (1905) ? through Boulder Clay.

Bocking.

Ordnance Map 223, new ser. (Essex 25, SW.). Geologic Map 47.

1. Beech Holme, Bradford Street, Dr. Taylor's. 1887 ?
Communicated by Dr. T. Taylor.
$157\frac{1}{2}$ ft. above the sea-level.
Sunk about 40 ft., the rest a 2-in. boring.
Water-level 28 ft. down. (1899.)

Ample supply, but a yellow ferruginous deposit is thrown down from the water after standing. Hardness 10°.

Bocking, cont.

		Thickness. Ft.	Depth. Ft.
Old well, the rest bored [partly through Drift]		—	35
[London Clay.]	London clay	5	40
	Clay mixed with sand	30	70
	Blue clay	30	100
	Clay and sand, with 10 in. claystone at top	15	115
	Clay and stone	2	117
	Clay and sand	11	128
	Sand	2	130
[Reading Beds, 54 ft.]	Light-coloured clay	7	137
	,, ,, ,, brown and sandy	13	150
	Dark clay	15	165
	Dark sandy clay	2	167
	Coloured [mottled] sand	7	174
	Light-green sand	6	180
	Light-brown sand	4	184
[Thanet Beds, 33½ ft.]	Grey sand	23	207
	Dark brown mud, like sand	7	214
	Dark green sand	3	217
	Flints	½	217½
[Upper] Chalk		53½	271

The divisions of the Tertiary beds above made are somewhat doubtful. For an analysis of the water see p. 360.

2. Messrs. Courtaulds' Crape Mills, Church Street. 1865.

(Courtaulds' Silk mills are in Braintree.)

Sunk and communicated by Messrs. Docwra, with some information from the Report of the British Association for 1883, pp. 155, 156, which has a slightly different account of the section.

137 ft. above Ordnance Datum.

Shaft 40 ft., the rest bored.

Yield: originally 16,000 gallons a day overflowed and 9,000 an hour were pumped. In July, 1867, after running to waste night and day for two years, the yield had fallen to 2,000 an hour. In 1883 waste had been stopped, and the well would yield 5,000 an hour.

From 1900–1910, 100,000 a day used (see also in water-levels below).

September, 1910. Bore being deepened to increase the yield.

		Thickness. Ft.	Depth. Ft.
Soil, etc.		7	7
[London Clay.]	Sandy clay, 7 or 8 ft. / Blue clay, 45 or 46 ft.	53	60
	Clay-stone and cement-stone with small vein of sand yielding soft water (200–400 galls. an hour, rising to 3½ ft. down)	3	63
	Clay, with a few cement-stones; shells at 77 ft.	17	80
	Stone	1½	81½
	Veiny clay	3½	85
[? London Clay.]	Dark sand (? and sandy clay), with a few shells	6	91
	Light-coloured sand	4	95
	Live sand	2	97
	Clay and sand	3	100
	Light-coloured sand	6	106
	Clay	4	110
	Pebbles	2	112

Bocking, cont.

		Thickness. Ft.	Depth. Ft.
[Lower London Tertiaries, 75 ft.]	Live sand	15	127
	Coloured clay with sand	3	130
	Sand	7	137
	Brown clay	2	139
	Clay and sand	4	143
	[Sand]	4	147
	Coloured clay	8	155
	,, ,, [? with sand]	4	159
	Dead light-coloured sand	8	167
	Dark dead sand...	18	185
	Green sand	2	187
[Upper.] Chalk	... ...	57	244

Water said to have reached a height of 7½ ft. above the ground (? 1865).

The water-levels of this well are especially interesting as they were affected by the Essex earthquake of April, 1884, and repeated measurements were made before and after this occurrence. The following record is summarised from the Reports of the British Association Underground Water Committee, for 1883, 1886.

Water-levels taken on Monday mornings after the well had been idle on the Sunday.

Between 1 January, 1883, and 21 April, 1884, the water-level varied from 19 in. above ground (26 March, 1883) to 8 in. above ground (8 October, 1883, and 24 December, 1883), and showed a marked but irregular or fluctuating tendency to fall.

21 April, 1884. 12 in. above ground.
22 ,, ,, Essex earthquake.
28 ,, ,, 31½ in. above ground, and from this date till 14 July, 1884, the level rose steadily with occasional slight fluctuations to 58½ in. above ground.

From 14 July, 1884, to 22 August, 1887, the water fell, steadily but with occasional slight fluctuations, the lowest record being 18 in. above ground on 8, 15, and 22 August, 1887, and it was estimated that if the rate of falling were maintained the effect of the earthquake would have disappeared by April, 1888.

In 1900 the water-level was 5 ft. below ground. Pumping at 100,000 gallons a day from 1900–1910 reduced the level 1¼ ft. a year. In 1910 the rest-level after the week-end was 17 ft. down.

The temperature of the water has been recorded as about 55° F.

For analysis of the water, see p. 360.

3. Boring for supply of Bocking (Braintree Rural District Council).

At Four Releet (near 4 cross-roads), nearly a mile west of Bocking Church.

(? Made in 1907 to 400 ft. and finished or deepened in 1908.)

Information from Messrs. H. Tabor, E. H. Bright, H. W. Golding and G. Barrow, who examined specimens.

243 ft. above Ordnance Datum.

Dynamite exploded at 400 and 500 ft. down increased the yield considerably.

Water-level 124 ft. down (1907).

Yield (Jan., 1908) about 3,000 gallons an hour (? pump being 250 ft. down), the water-level falling to 224 ft., recovering in 2 hours. In 1909, the pump being 304 ft. down, the yield was less than 2,000 gallons an hour.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Chalky boulder clay, decalcified at top	29	29
	Sand and fine gravel	10½	39½
	Ferruginous sand	22	61½
[London Clay, 141 ft.]	Clay with septaria, lighter-coloured near base	111	172½
	Silty clay	17½	190
	Faintly mottled yellow and sandy clay	12½	202½

Bocking, cont.

		Thickness. Ft.	Depth. Ft.
[Lower London Tertiaries, 90 ft.]	Pale yellow-brown sand	16	$218\frac{1}{2}$
	Decomposed reddish faintly mottled clay	4	$222\frac{1}{2}$
	Yellow sand	5	$227\frac{1}{2}$
	Greenish-grey clay	10	$237\frac{1}{2}$
	Brown and grey sand	18	$255\frac{1}{2}$
	Marly yellow and grey clays with carbonaceous fragments	13	$268\frac{1}{2}$
	Greenish-grey and bright green sands	12	$280\frac{1}{2}$
	Pale sandy clay with a little race ...	4	$284\frac{1}{2}$
	*Brown and grey sand (clayey) ...	5	$289\frac{1}{2}$
	Flints	3	$292\frac{1}{2}$
[Upper.] Chalk		$211\frac{1}{2}$	504

* This bed more clayey than is usual near London. It was *mixed*, not in separate films. The thickness between the base of the green sand and the chalk is also less than in the London area.

This bore was abandoned. Yield insufficient.
For analysis of the water, see p. 359.

4. Church Street, close to the Cemetery. 280 yds. south-east of St. Mary's Church. For the Braintree Rural District Council. 1911.
133 ft. above Ordnance Datum.
Communicated by Messrs. Sands and Walker.

Yield, ascertained by continuous pumping for 14 days, 204,000 gallons a day. Water-level before pumping 18 ft. down (115 above O.D.), and after pumping, 24 ft. down, the water regaining the original level in about 8 hours. Lined with $202\frac{1}{2}$ ft. of $10\frac{5}{8}$-in. tubes.

		Thickness. Ft.	Depth. Ft.
Made ground...		4	4
Gravel...		$\frac{3}{4}$	$4\frac{3}{4}$
[London Clay, $79\frac{1}{4}$ ft.]	Brown clay	2	$6\frac{3}{4}$
	Blue clay, with claystone from $19\frac{3}{4}$ to $20\frac{1}{2}$ ft. down, and from 40 to $40\frac{1}{2}$ ft.	$77\frac{1}{4}$	84
[Reading Beds, $31\frac{1}{2}$ ft.]	Sand	$3\frac{1}{2}$	$87\frac{1}{2}$
	Brown or mottled clay...	28	$115\frac{1}{2}$
[Thanet Beds, $48\frac{1}{2}$ ft.]	Dead grey sand	$47\frac{3}{4}$	$163\frac{1}{4}$
	Sand and flints	$\frac{3}{4}$	164
[Upper.] Chalk		161	325

In July, 1912, wells were being sunk round the bore-tubes. Water was coming into the wells [from the upper strata]. Analyses on p. 359.

Dr. Thresh's Report of 1901, p. 116, says that the section of the parish on the eastern side of the workhouse then depended on shallow contaminated wells. Now (1913) the waterworks have been completed and the houses are being connected to the mains.

Boreham.

Ordnance Map 241, new ser. (Essex 44 SW.). Geologic Map 1, NE. and 47.
Old wells. Information from the sinker, Mr. Rolfe, to W. H. Dalton.

1. In the village. Sand and gravel, 12 ft.
2. Brent Hall.

[Glacial Drift.] { Boulder Clay 20, Sand and gravel 10 } 30 ft.

According to Dr. Thresh's Report of 1901, p. 101, a public well and two public springs all yielded good water. Many houses were supplied by private wells.

According to his Report of 1905, p. 47, water is obtainable over most of the area; but at some places near the boundary, where the sand is covered by a considerable thickness of Boulder Clay, wells 20 to 40 ft. deep yield very little water, and that unsatisfactory in character.

Borley.

Ordnance Map 206, new ser. (Essex 6, SW.). Geologic Map 47.

According to Dr. Thresh's Report of 1905, p. 79, a tube-well had been recently sunk for public supply. Chalk was reached at 82 ft. and penetrated to the depth of 126 ft., when sufficient water was got.

Bowers Gifford.

Ordnance Map 258, new ser. (Essex 77, NW.). Geologic Map 1, SE.

Dr. Thresh's Report on the Water Supply of Essex, 1901, p. 82.

There was a public pump, the joint property of Bowers Gifford and Pitsea, in the latter parish, and there were two private wells. Some inhabitants had to go a mile to the pump. A few collected rain-water.

Dr. Carter (M. O. H. of Billericay Rural Ditsrict) says, that at South Staines Farm a well was made to the depth of 300 ft., and then abandoned. The place is now supplied by the Southend Water Co.

Southend Water Co.'s Bowers or No. 15 Well. A quarter-mile W. of Bowers Church. 1906.

Communicated by E. C. Bilham, Engineer to the Company.

39·5 ft. above Ordnance Datum.

Sunk portion 295 ft. 24-in. pipe to 317 ft.

Highest water-level 97·5 ft. down. Lowest (pumping) 269·5.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil	...	1	0	1	0
[London Clay]	Yellow clay. Clay nodules [septaria] at 24 ft.	24	0	25	0
	Brown clay. Clay nodules [septaria] at 33 ft.	10	0	35	0
	Blue clay, with 13 layers of clay nodules [septaria] a few feet apart down to 201 ft. and nodules and pyrites at 226 and 228 ft. ...	274	5	309	5
[?Oldhaven Beds]	Sand and pebbles ...	1	1	310	6
	Sand ...	7	4	317	10

For an analysis of the water, see p. 360.

Boxted.

Ordnance Map 224, new ser. (Essex 18, NE.). Geologic Map 48, NW.

Dr. J. W. Cook's Report for 1900, repeated in Dr. Thresh's Report of 1901.

Shallow wells abound and were the only source of supply.

New wells have been made, of concrete-tubes, about 21 ft. deep, with from 8 to 10 ft. of water.

Bradfield.

Ordnance Map 224, new ser. (Essex 20, SW.). Geologic Map 48, NW.

In field 181 of the 25-in. Ordnance Map.

116 ft. above Ordnance Datum. Trial-boring. 1885.

A little water found at a depth of 309 ft., and a little more at 403, which stands at 109 ft. (or 11 ft. above Low Water Level). Yielded only 11 gallons a minute.

			Thickness. Ft.	Depth. Ft.
Soil	...		$1\frac{1}{2}$	$1\frac{1}{2}$
[Drift, $24\frac{1}{2}$ ft.]	Loamy sand, with a little gravel		4	$5\frac{1}{2}$
	Brown, loamy sand		$13\frac{1}{2}$	19
	Light-coloured sharp sand		$6\frac{1}{4}$	$25\frac{1}{4}$
	Gravel ...		$\frac{3}{4}$	26
[London Clay 111 ft.]	Brown clay		1	27
	Blue clay		97	124
	[Basement-bed.]	Hard grey sand, with small stones [? flint-pebbles.]	9	133
		Hard green sand	4	137

Bradfield, cont.

		Thickness. Ft.	Depth. Ft.
[Reading Beds, 59 ft.]	Light-coloured clay	12	149
	Hard light-coloured brown sand	20	169
	Light-green clay	5	174
	Dark green clay, with sand	3	177
	Black clay	12	189
	Green-grey loamy sand, with a few green-coated flints at bottom	7	196
[Upper.] Chalk: Flints about 2 ft. down, and then none till 309 ft. from the surface. From 375 to 425 ft. flints were found every 2 or 3 ft. From 294 to 330 ft. the chalk was soft and rubbly, the rest was tough and close, except at about 403 ft.		267	463

According to Dr. THRESH's Report of 1901 the supply was then from shallow wells. The place is now in the area of the Tendring Hundred Water Co.

Bradwell juxta mare.

Ordnance Map 242, new ser. (Essex 55, NE.).
Geologic Map 2.

According to Dr. THRESH's Report of 1901, p. 109, water was fairly abundant and got from the public and many private pumps. Wells shallow and nearly all showed signs of pollution, some serious. The public pump at the end of the village gave very good water.

Braintree.

Ordnance Map 223, new ser. (Essex 25, NW., SW.). Geologic Map 47.

1. Mr. Brown's.
Trial-bore, made and communicated by Mr. BROWN.

		Thickness. Ft.	Depth. Ft.
Drift, 14 ft.]	Sandy gravel	5	5
	Drift clay	9	14
[London Clay, 126 ft.]	London Clay	56	70
	Vein of sand, with a little water	—	—
	London Clay, sand and shells	40	110
	Cement-stone	1	111
	London Clay, and sand	29	140
[Reading Beds, 55 ft.]	Dark sand, with water	10	150
	Mottled clays	45	195
Light-coloured [Thanet ?] sand		33	228
[Upper] Chalk		17	245

2. Courtaulds' Silk Mills. 1886. Their crape mills are in Bocking.
Communicated by D. R. SHARPE.

$135\frac{1}{2}$ ft. above Ordnance Datum. Shaft and bore.

Water first noticed 242 ft. down. When the well was finished the water stood $29\frac{3}{4}$ ft. down. 1,000 gallons an hour pumped, during working hours. Temperature of water, at the surface, about 50°.

		Thickness. Ft.	Depth. Ft.
Mould		2	2
[? Alluvium and Drift.]	Blue sandy clay...	3	5
	Yellow sandy clay	4	9
	Sand	3	12
	Stones [? gravel]	$\frac{1}{2}$	$12\frac{1}{2}$
[London Clay, $118\frac{1}{2}$ ft.]	London clay	68	$80\frac{1}{2}$
	Blue sandy clay...	3	$83\frac{1}{2}$
	London Clay, with clay-stones (6 inch at 92, 10 inch at 96, and 2 inch lower down) ...	$18\frac{1}{2}$	102
	Dark sandy clay, with shells	18	120
	Light-coloured clay	10	130
	Clay and pebbles [basement-bed]	1	131

Braintree, cont.

		Thickness. Ft.	Depth. Ft.
[Reading Beds, 45 ft.]	Mottled clay	30	161
	Dark red clay	3	164
	Coloured [mottled] sand	12	176
[Thanet Beds, 36½ ft.]	Light-coloured sand	24	200
	Dark green sand	10	210
	Light-coloured sand	2	212
	Flints	½	212½
[Upper] Chalk ...	... ...	108½	321

For an analysis of the water, see p. 363.

Waterworks.

These are between the railway and the stream, about a sixth of a mile west of the station and east of the road. Two wells (3, 4).

Dr. Reece, in his Report to the Local Government Board, 1907, says of the water-supply of the Urban District Council:—" Since the wells have been sunk the level of the water has dropped at the rate of about one foot per annum. In November 1888 the water in them stood at a depth of 41 feet 2 inches . . . in August, 1904, at 56 feet 2 inches; it now (? September, 1907) stands at about 60 feet . for practical purposes all the water is pumped from the New well. . . . The two wells are not connected, but they are only a few feet apart, and pumping from one well affects the level of the water in the other."

" There are comparatively few private wells now in use in the town of Braintree. In the more rural parts of the Urban District the supply is derived from shallow or 'dip' wells. Of such wells, both inside the town and in the country, many are manifestly liable to pollution."

According to the Water Works Directory, 1911, the works were established in 1856. The population of the area supplied was about 6,000. The daily supply was 130,000 gallons, for the year ending 31 March, 1911.

3. Well of 1856. For the Local Board (now Urban District Council). In a field near Pods Brook on the same spot as a trial-boring.

From Dr. R. J. Reece's Report to the Local Government Board, No. 28, 1907, and from an account by A. C. Veley in the 'Essex Herald,' 21 March, 1854. (Veley's section refers to the trial-bore, but, except for a little absence of detail, is identical.)

145 or 146 ft. above Ordnance Datum.

Shaft, 10 ft. diameter, 72 ft. (55 Veley), with a 10-in. boring from the bottom.

Water-level 29 ft. down (Veley), 12 ft. down (Reece). Is this a rise in water-level due to the 1884 earthquake which affected this district? See p. 65.

Yield: Pumps worked on an average 4½ hours a day at 11,500 gallons an hour (Veley).

		Thickness. Ft.	Depth. Ft.
[Drift.]	Sandy gravel	5	5
	Drift clay	9	14
[London Clay, 136 ft.]	Clay	56	70
	Thin vein of sand with a little water...	—	—
	Clay with sand and shells	40	110
	Hard cement-stones (septaria) under which water was found and rose to within 5 ft. of the surface	about 1	111
	Clay, getting gradually more sandy ...	about 29	140
	Dark sand with a few shells, yielding much water [? Basement-bed or Oldhaven Beds]	10	150
[Reading Beds, 45 ft.]	Mottled plastic clays, getting more sandy lower down and " with specks of chalk " [" race " or calcareous concretions]	44	194
	Coarse black sandy clay	1	195

Braintree, cont.

		Thickness. Ft.	Depth. Ft.
[Thanet sand. 33 ft.]	Light-coloured sands, firm and hard, getting darker and more friable lower down	20	215
	Light-coloured sands, firm, changing to coarse and dark	13	228
[Upper] Chalk with much water		17	245

According to B. LATHAM (*Trans. Soc. Eng.* for 1864, p. 242), this well had been bored 150 ft. deeper, the supply was 45,000 gallons a day, and the water-level rose with the rise of the tide!

According to the sixth Report of the Rivers Pollution Commission (1874, p. 322), the well was 430 ft. deep.

According to information from D. R. SHARPE, of Braintree, the boring was deepened 100½ ft. in 1857; he adds that "it is said that this last boring caused a gradual sinking of the water, and that the well at Bocking Silk-mill caused the water to fall at a greater rate."

4. Another well, about 40 ft. from the former. 1888.
146 ft. above Ordnance Datum.

Made and communicated by Messrs. DOCWRA, and from Dr. REECE's Report to the Local Government Board, No. 282, 1907.

Shaft 9 to 8 ft. in diameter, 103 ft. Then a 12-in. boring.

Water rose to 39 ft. 2 in. down (? originally), to 41 ft. 2 in. in 1888 (? later), and to 50 ft. in 1899. After some days pumping, 68 ft. down (1899).

Yield: Pumping is intermittent, 2 to 3 hours at a time, say 8½ hours a day, at 14,000 gallons an hour, say 130,000 gallons a day. Would yield much more.

			Thickness. Ft.	Depth. Ft.
Soil and water			4	4
[? Alluvium and Drift.]	Loamy clay		2	6
	Loamy clay and ballast [gravel] ...		8	14
[London Clay, 115 ft.]	Blue clay, with a foot of clay-stone [septaria] at 105—106, and at the bottom		110	124
	[Basement-bed.]	Blue clay and sand ...	2	126
		Dark sand with water	3	129
[? Basement-bed of London Clay, or Reading Beds.] Dark sand with water			14	143
[Reading Beds]. Mottled clay [a specimen from D. R. Sharpe, marked 190 (? for 170) feet, of green brown and red mottled firm sand]			35	178
[Thanet Beds, 44 ft. ?]	Thanet sand [a specimen, from Mr. Sharpe, marked 212, brown clayey firm sand]		43½	221½
	Flints		½	222
[Upper.] Chalk and flints			107½	329½

For analyses of the water at these works, see pp. 361–363.

Bramble Island, see **Beaumont.**

Braxted, see **Great Braxted.**

Brentwood.

Ordnance Map 257, new ser. (Essex 67, NW., NE.). Geologic Maps 1, NW., and (part) London District, Sheet 2.

1. Essex Lunatic Asylum. 1886. (In South Weald.)
300 ft. above Ordnance Datum.
Made and communicated by Messrs. S. F. BAKER and SON.

Brentwood, cont.

Shaft 410 ft. 4 in., the rest bored $7\frac{1}{2}$ in. diameter.
Water-level 209 ft. down, 340 in 1911.
Yield 325 gallons an hour (July, 1898); originally much more.

		Thickness. Ft.	Depth. Ft.
Surface mould...	...	3	3
[London Clay, 415 ft.]	Yellow clay	7	10
	Sandy clays, with a few black pebbles (classed as Bagshot Beds by Messrs. Baker)	$36\frac{1}{2}$	$46\frac{1}{2}$
	Blue clay	$371\frac{1}{2}$	418
[Woolwich and Reading Beds, 71 ft.]	Coloured [mottled] clay	7	425
	Stone	$1\frac{1}{2}$	$426\frac{1}{2}$
	Marl with shell-fragments	$1\frac{1}{2}$	428
	Fine light-coloured sand	$1\frac{1}{2}$	$429\frac{1}{2}$
	Light-grey stone	$\frac{3}{4}$	$430\frac{1}{4}$
	Light-coloured clay	$1\frac{1}{2}$	$431\frac{3}{4}$
	Dark sand	31	$462\frac{3}{4}$
	Pebbles	$2\frac{3}{4}$	$465\frac{1}{2}$
	Sandstone	$\frac{1}{2}$	466
	Dark green sand and pebbles	23	489
[Thanet Beds, $64\frac{1}{2}$ ft.]	Grey sand	53	542
	Clayey sand	$10\frac{1}{2}$	$552\frac{1}{2}$
	Flints	1	$553\frac{1}{2}$
[Upper] Chalk	...	$155\frac{1}{2}$	709

If the sandy clays, near the top, are classed as Bagshot Beds the total thickness of the London Clay is only $371\frac{1}{2}$ ft., unless perhaps some of the upper beds classed with the Woolwich Series belong to the 'basement-bed.' In this neighbourhood we should expect a total thickness of London Clay of about 450 ft; so that it seems probable that the top of that formation is not here present, and all the more probable that we have no Bagshot Beds.

For an analysis of the water, see p. 364.

2. Merry Meade. Cricket-ground opposite Middleton Hall, High Street. 1913.
About 350 ft. above Ordnance Datum.
Made and communicated by Messrs. A. Williams & Co.
Well 27 ft., the rest a 5-in. boring.
Water-level 340 ft. down. Yield 600 gallons an hour. Analysis, p. 364.

		Thickness. Ft.	Depth. Ft.
[Bagshot ?]	Loamy sand	41	41
[London Clay, 483 ft.]	Brown clay	4	45
	Blue clay and layers of sand	28	73
	Grey sand	34	107
	Blue clay and stones	9	116
	Sand and clay	7	123
	Blue clay and layers of sand	10	133
	Blue clay and stones	391	524
[? Oldhaven Beds, $20\frac{1}{2}$ ft.]	Grey loamy sand	$5\frac{1}{2}$	$529\frac{1}{2}$
	Dead loamy sand and bed of shells	7	$536\frac{1}{2}$
	Grey loamy sand	$3\frac{1}{2}$	540
	Clayey sand and pebbles	3	543
	Black pebbles	$1\frac{1}{2}$	$544\frac{1}{2}$
[Reading Beds, $49\frac{1}{2}$ ft.]	Hard grey sand	16	$560\frac{1}{2}$
	Dead coloured sands	6	$566\frac{1}{2}$
	Green sand and pebble	$1\frac{1}{2}$	568
	Live grey sand	1	569
	Hard green sand	18	587
	Live green sand	3	590
	Loamy green sand	4	594
[Thanet Sand, 73 ft.]	Dead grey sand	10	604
	Loamy grey sand	63	667
[Upper.]	Chalk and flints	16	683

Brightlingsea.

Ordnance Map 242, new ser. (Essex 37, SE.). Geological Map 48, SW.

Public Well. For the Urban District Council. 1899.
Five-eighths of a mile north of railway-station.
Made and communicated by Messrs. TILLEY, with additional details from H. GOODYEAR and H. S. COOPER.
80·19 ft. above Ordnance Datum.

Rest-level of water from the Chalk, 73 ft. down, from the gravel, 32 ft. 8 in. down. Ten days' pumping, at an average of over 128,000 gallons a day, reduced the level to 136 ft. down. On stopping pumping water rose 36 ft. 8 in. in four minutes and regained the original level in just one hour. This yield (128,000 gallons a day) was just double the requirements of the town at that time (? 1899).

The surface-water (from the first 14 ft.) is excluded by a 20-in. tube into the London Clay, and the boring is lined with 15-in. tubes some way into the Chalk.

		Thickness. Ft.	Ins.	Depth. Ft.	Ins.
Soil		1	6	1	6
[Glacial Drift.] Well charged with water.	Red Sand	3	0	4	6
	Light-coloured sand	2	0	6	6
	Sand	2	0	8	6
	" Hard core "	0	6	9	0
	Loam	1	0	10	0
	Sand	3	6	13	6
	Gravel	1	0	14	6
	Sand	6	6	21	0
	Gravel	2	6	23	6
	Sand	0	10	24	4
	Gravel	21	8	46	0
[London Clay.]	London Clay	71	0	117	0
	Loamy clay	5	0	122	0
[Reading Beds and Thanet Sand.]	Mottled clay	4	0	126	0
	Mixed clay	2	0	128	0
	Yellow clay	5	6	133	6
	Blue mixed clay	2	0	135	6
	Green and red mixed clay	6	0	141	6
	Mixed loamy clay	3	0	144	6
	Light-coloured clay	4	0	148	6
	Dark sand (water)	4	6	153	0
	Green sandy clay	4	0	157	0
	Slate-coloured clay	6	0	163	0
	Dark loamy sand	22	0	185	0
	Green sandy loam	2	6	187	6
	Flints	0	6	188	0
[Upper] Chalk (very soft)		45	0	233	0

There is another (newer) bore 12 ft. from this one. For analyses of the water of both, see p. 364.

Also published with slight differences and less detail in Dr. THRESH'S Report on the Water Supply of the County of Essex, 1901, p. 30.

The following information from the Water Works Directory, 1911, p. 64:—

The works were established in 1869 and bought by the local authority in 1899. The population supplied (Brightlingsea only) is 4,006. The supply is constant, and the average daily supply is 20 gallons a head. Year ended 31st March, 1911.

According to Dr. THRESH'S Report of 1901, p. 130, much of the town was then supplied from the shallow well of the old Company, which was dangerously near to a number of houses.

Since then most of the wells in the place have been closed and the new public supply laid on. The water being harder than that of some of the shallow wells, some inhabitants prefer the latter.

Bromley, see **Great Bromley.**

Broomfield.

Ordnance Map 241, new ser. (Essex 43, SE.). Geologic Maps 47 and 1, NE.

1. For the Chelmsford Rural District Council. 1911. 1,200 yds. south of the Church.

110 ft. above Ordnance Datum.

Communicated by J. DEWHIRST.

Water-level 60 ft. down.

,, after pumping $171\frac{1}{2}$ ft. down.

,, ,, ,, 12 days at 86,000 to 120,000 gallons a day, 186 ft. down.

Original water-level regained 6 days after pumping ceased, and water rose to within 20 ft. of the original level in 24 hours.

Yield (14 days' pumping) 120,000 gallons a day (contract-limit). (1911.)

Water very soft and well adapted for all domestic purposes.

		Thickness. Ft.	Depth. Ft.
Soil	...	1	1
[Drift.]	Brick-earth	6	7
	Flints, gravel and sand	8	15
[London Clay.]	London Clay	97	112
	,, ,, and silty and loamy clay	85	197
	Stone	1	198
	Silty clay	10	208
	Stone	1	209
	Dark silty clay	7	216
[Basement-bed of London Clay; and ? Oldhaven Beds.]	Silty clay and pebbles	4	220
	Sandy clay and pebbles	6	226
	Hard sand	3	229
	Clay and pebbles	2	231
[Reading Beds.]	Red mottled clay	3	234
	Green sandy loam	4	238
	Green silty clay	12	250
	Grey clay and pebbles	6	256
[Thanet Sand.]	Watery sand	2	258
	Fine dry sand	12	270
	Fine grey sand	30	300
	Close hard sand	13	313
	Green, brown, black and grey mottled sand	7	320
Flints and chalk	...	$1\frac{1}{2}$	$321\frac{1}{2}$

For analysis of the water, see p. 365.

Dr. THRESH, in his Report on the Water Supply of Essex, 1901, p. 101, says that the village got water from 54 wells, all but one shallow, and two springs. Of the wells, eight failed in summer, the rest yielding a plentiful supply. Waters from 47 wells were analysed, with the result that 21 were found impure and ten doubtful.

2. Broomfield Hall. Near the Church.

140 ft. above Ordnance Datum.

Water-level 70 ft. down.

Yield, tested for 14 days, gave 100,000 gallons a day. (? since April, 1909.)

	Thickness. Ft.	Depth. Ft.
Stony clay soil	25	25
Blue clay	183	208
Hard rocky strata	17	225
Sand with water	5	230

For analysis of the water, see p. 366.

Broomfield, cont.

3. At the back of Phillibrows Cottages. Shallow well (only a few feet deep) used for drinking-purposes. (1912.)
Water from sand under Boulder Clay.
Water-level nearly at ground-level.

It was examined (April, 1912) because of the large amount of nitrates present in the water. For analysis of the water, see p. 366.

Broxted.

Ordnance Map 222, new ser. (Essex 14, SE., 23, NE.). Geologic Map 47.

Sucksted (or Sugstys) Green. Where the P (= pump) is marked, between the roads, on the Ordnance Six-inch Map 14, SE.
About 348 ft. above Ordnance Datum.
Sunk and communicated by Mr. G. Ingold. Shaft.

		Thickness. Ft.	Depth. Ft.
[Boulder Clay.]	White and brown clay ...	14	14
	Chalky sand and stones	2	16
	Blue clay	13	29
[Glacial Drift.]	Sand	11	40
	Blue clay	19	59
	Sand and gravel ...	$2\frac{1}{2}$	$61\frac{1}{2}$

According to Dr. Thresh's Report of 1901, p. 117, the place was then supplied from five public wells. During the past summer the water in these had been very low.

Bulmer.

Ordnance Map 206, new ser. (Essex 12, NW.). Geologic Map 47.

Armsea, about a mile south-west of Sudbury.
Sunk and communicated by Mr. Cooper (of Halstead).
Shaft 96 ft., the rest bored.

	Thickness. Ft.	Depth Ft.
Chalky clay [Boulder Clay ?]	30	30
Sand, greenish at bottom ...	25	55
Chalk	about 195	250

For note of wells at Auberis and Smeetham Hall, see p. 366.

Dr. Thresh's Reports of 1901 and 1905 state that the village is partly supplied by deep wells, yielding pure water, partly from ponds. The owners of 22 cottages recently combined to sink a well, which got a good supply at 50 ft.

A letter from Col. Burke (of the Auberies), with a map, makes some corrections and gives further particulars, as follows:—'There were (1905) 23 wells, 20 ft. and more deep (one doubtful, two with pumps out of repair), six wells under 20 ft. deep, and four good perennial springs. There were also other shallow wells not used for drinking purposes. A beerhouse and a row of four adjacent cottages were the only places dependent on a pond, which is supplied by a strong spring and is not liable to contamination. Other ponds are used for household purposes only. The row of 22 cottages always had a well, which was sufficient until pumping in connection with the Sudbury Sewage Works lowered the level of the underground water, when the well was deepened (not made).

Some of the wells must be in Glacial gravel; but some may be in Reading Beds. Two of the springs are marked as at buildings a quarter of a mile and nearly half a mile in the valley north-east from Auberies and two as at buildings about a third and nearly two-thirds of a mile southward of Goldingham Hall.

Bulphan.

Ordnance Map 257, new ser. (Essex 75, NE., SE., 76, NW., SW.).
Geologic Maps 1, SW. and SE.

1. Bulphan Fen (at the edge of the uplands). Bored. 1835.
SWINDELL and BURNELL's Rudimentary Treatise on Well-digging, etc., Ed. 4, p. 99. Lond. 1860.
Level of surface about High Water Mark.

Water rose to within a foot of the surface; temperature about 51° Fahr. all the year round; quantity about 30,000 gallons a day.

	Thickness. Ft.	Depth. Ft.
[Alluvium] { Alluvial soil, gravelly	5 or 6	5 or 6
[Alluvium] { Soft boggy earth	2	7 or 8
Light-brown [Thanet] sand, firm, sharp and fine, darker lower down, and at 65 ft. from the surface almost black. At the bottom a little green flaky rock. [Exact thickness not given, but must be 58 ft. at least]	say 60	68?
[Upper.] Chalk with flints	42	110?

2. Bulphan Fen. Beerhouse.
14 ft. above Ordnance Datum. Water still overflows (1898).

Alluvium	6	108 ft.
Thanet sands about	60	
Chalk, with flints ...	42	

There are several overflowing borings in Bulphan Fen, fitted to cattle troughs.

The analyses of the water from one near the roadside and of the one at the Beerhouse are given on p. 367.

The one near the roadside (18 ft. above Ordnance Datum) overflows at about 4 ft. above ground at the rate of about one gallon a minute.

3. Bulphan Rectory. A well (26 ft. above Ordnance Datum) 128 ft. deep.
Water-level 2 ft. down.

4. Bulphan Hall. Well 130 ft. deep.
Water-level 5½ ft. down.

A man engaged in sinking a well near by, told Mr. ROLFE and Dr. THRESH that water is generally found here (Bulphan) at 120 to 130 ft. down, in sand, chalk not being reached.

5. In Doesgate Lane, near Wick House. To supply some cottages. 1900.
31 ft. above Ordnance Datum.
Water-level 13 ft. down.
Dug and bricked 25 ft. Bored 80 ft. (? Total 125.)
For an analysis of the water, see p. 367.

The water (probably from Oldhaven Beds) of a well at a cottage here (25 ft. deep. Water-level 20 ft. down). Analysis on p. 367.

Bures (Hamlet).

The village of Bures St. Mary is in Suffolk.
Ordnance Survey 223, new ser. Geologic Map 48, NW.

There is a public well, fed by a spring yielding good water, and there are several private wells (in gravel). Some outlying cottages use springs and ponds.

Burnham.

Ordnance Map 258, new ser. (Essex 63, SW., SE., 71, NW., NE.).
Geologic Map 2.

1. Public Supply.

Dr. H. T. BULSTRODE's Report upon an outbreak of Diphtheria, p. 2, Fol. *Lond.*, 1902, gives the following information:

Burnham, cont.

"Up to quite recently the water supplying the town was derived from an area of sand and gravel of about 100 acres in extent, overlying the London clay at a relatively elevated situation towards the north-west of the town, tube wells having been used for the purpose."

"But the level of this water, which was originally within 8 feet of the surface, has been for some considerable time steadily sinking, and, in March, 1900, it had sunk [to] 25 feet below the ground level." Advice to get a supply from the Thanet Sands was not followed "and unsuccessful efforts were made to procure a more abundant supply from the superficial beds." A deep boring was then made and "water was eventually obtained from the Thanet sands, and it was from this source that the town was being supplied at the date of my visit."

"The bore-hole is lined with steel pipes 11·5 inches in diameter to within a few feet of the bottom."

"There were being pumped up at the date of my visit 35,000 gallons per diem, and the quality of the water was apparently satisfactory. The only drawback at that time was the large amount of sand which was held in suspension by the water."

The following is an account of the above boring, opposite the Church, 1901, made and communicated by Messrs. LE GRAND and SUTCLIFF.

$11\frac{1}{2}$ in. in diameter.

52 ft. above Ordnance Datum.

Water-level: In 1901, 72 ft. down; in 1909, 141 ft. down. (In 1901 or 1902 pumping at 1,500 gallons an hour reduced the water-level to 145 ft. down.—J. C. T.)

		Thickness. Ft.	Depth. Ft.
[River Gravel.]	Ballast	26	26
[London.]	Blue clay	359	385
[? Oldhaven Beds and Reading Beds.]	Grey sand and shells	10	395
	Sand and clay in bands ...	6	401
	Sand, clay, shells and pebbles ...	$5\frac{1}{2}$	$406\frac{1}{2}$
	Sand and shells	5	$411\frac{1}{2}$
	Blowing sand	$2\frac{1}{2}$	414
	Sandy clay and shells	1	415
	Coloured clay	$4\frac{1}{2}$	$419\frac{1}{2}$

Population of area supplied 3,000. (Water Works Directory, 1911.) The mains have been extended to the hamlet of Ostend (NW.).

For analyses of the waters from both sources, see p. 368.

2. Mr. Stagg's Windmill. Old well. Information from Mr. PURKIS, the sinker, to W. H. DALTON.

Gravel	20	320 ft.
London Clay, to sand ...	300	

3. Burnham Marshes. Coney Hall. Old Well. Information, of this and the following, from Mr. HATLEY, the sinker, to W. H. DALTON.

[Alluvium]	Shell-sand	8	380 ft.
	Gravel, shells and mud ...	72	
London Clay, to sand		300	

4. Burnham Marshes. Deal Hall. Old well.

Shells, silt and sand [Alluvium] ...	80	350 ft.
London Clay, to sand	270	

Burstead, see **Great** and **Little Burstead.**

Burstead [? Bustard] **Green,** see **Lindsell.**

Buttsbury, see **Stock.**

Canewdon.

Ordnance Map 258, new ser. (Essex 70, NE.). Geologic Map 1, NE.

1. Cricksea Ferry (S. side). Old well. Information from Mr. PURKIS, the sinker, to W. H. DALTON.

	Thickness. Ft.	Depth. Ft.
Alluvium	60	60
Blue clay	280	340
Sandy clay	40	380
Green sand	4	384
Shell-rock, to shelly sand, with water	over 1	385

In Sir J. PRESTWICH's MSS. it is recorded that good water was got and that it overflowed.

2. Public well. In the village. Communicated by the Rochford Rural District Council.

A little more than 100 ft. above Ordnance Datum.

Supply abundant and pure. In 1905 it supplied most of the parish.

Through London Clay, to sands beneath.

For analysis of the water, see p. 369.

3. Pudsey Hall.

From H. W. BRISTOW's Notes

Well 297 ft. deep, ending in blue [London] Clay.

Water abundant and good.

For analysis see p. 369.

4. Toftman's Farm. Communicated by Mr. PETTITT.

About 40 ft. above Ordnance Datum.

Sunk 60 ft. and bored 360 (? Total 420).

Rest-level of water 34 ft. down when sunk (DALTON).

Yield 10 gallons per minute (DALTON).

Superficial gravel about 16 ft. thick.
London Clay 330 ft. thick.
London Clay pierced and water obtained from Thanet Sands.
For analysis of the water, see p. 369.

Canfield, see Great Canfield.

Canning Town, see West Ham.

Canvey.

Ordnance Survey 258, new ser. (Essex 77, SW., SE., 85). Geologic Map 1, SE.

1. Eldon Engineering Co.

Made and communicated (1901) by Messrs. ISLER & Co.
315 ft. of pipe of 6 in. diameter, $1\frac{1}{2}$ ft. down.

		Thickness. Ft.	Depth. Ft.
Well [the rest bored]		—	6
[? Alluvium.]	Green sand ...	15	21
[London Clay.]	Mottled clay ...	58	79
	Clay	71	150
	Blue clay ...	135	285
	Green sand ...	37	322

Canvey, cont.

2. Waterside Farm (northern side of the island). 1890?
Made and communicated by Messrs. WADSLEY.
Water rose to within 9 ft. of the surface. Good supply.

		Thickness. Ft.	Depth. Ft.
Top ground ...		2	2
Quick sand [Alluvium]		28	30
[River Drift] gravel and flints		40	70
[London Clay.]	Clay and claystones ...	10	80
	London Clay ...	220	300
	Brown clay ...	20	320
Lower London Tertiaries.]	Green sand ...	97	417
	Brown sand ...	30	447
	Chalk [? calcareous stone] ...	2	449
	Black sand ...	10	459

W. H. DALTON has sent the following note:—An older well here is said (by the sinker, Mr. PURKIS) to pass through 70 ft. of Alluvium, 25 of gravel, and 200 of London Clay (to the base).

3. Waterside Farm. Another well. 1909.
Made and communicated by Messrs. ISLER & Co.
Lined with 100 ft. of 6-in. tubes from 4½ ft. down and with 400 ft. of 4-in. tubes from 2 ft. down.
Water-level 74 ft. down. Yield 200 gallons an hour.

		Thickness. Ft.	Depth. Ft.
Made ground ...		1	1
[River Deposits.]	Dark loamy sand ...	14	15
	Brown sand ...	40	55
	Brown clay ...	9	64
[River Drift.]	Ballast [gravel] and sand	12	76
Blue London Clay ...		236	312
[Oldhaven Beds.]	Sand and pebble ...	13	325
[Woolwich Beds.]	Dark rock ...	8	333
	Green sand ...	21	354
	Sand and pebble ...	8	362
[Thanet Beds.]	Loamy green sand ...	30	392
	Loamy sand ...	58	450
	Sandy clay ...	16	466
[Upper.] Chalk ...		26	492

4. Public Well. Near the Church.
Made and communicated by Mr. FURLONG.
About 9 ft. above Ordnance Datum.
Yield not known, but sufficient for surrounding people.

		Thickness. Ft.	Depth. Ft.
[River Deposits.]	Mud and ooze ...	26	26
	Blowing sand ...	54	80
London Clay ...		199	279
[Oldhaven Beds.]	Sand stone ...	6	285
	Sand and black pebbles	17½	302½

For analysis of the water, see p. 370.

5. According to Sir J. PRESTWICH (MS. 1849). A well in Canvey passed through 100 ft. of sand and shingle, full of salt water, and then through 300 ft. of London Clay [? including underlying sands, etc.]. Plenty of water, which overflowed.

6. Brick House. ? Old well.
Information got by Messrs. LE GRAND and SUTCLIFF.
To base of London Clay, 244 ft.

Canvey, cont.

7. South Sluice. Old well.

Information from Mr. PURKIS, the sinker, to W. H. DALTON.

Alluvium	70	195 ft.
[River] Gravel	25	
London Clay (to base) ...	100	

This differs much from others, and must be taken with doubt.

W. H. DALTON remarks on Nos. 6 and 7 that by comparison with that at Waterside Farm it seems that a sharp northerly dip occurs across the island. He adds that there is a synclinal along Benfleet Creek, beyond which place the beds rise northward.

According to Dr. THRESH's Report of 1901, p. 78, there is a deep well at an inn and a shallow one at the Coastguard Station. Many houses had rain-water tanks.

The place is now in the area of the Southend Co.

Castle Hedingham.

Ordnance Map 223, new ser. (Essex 11, SE.). Geologic Map 47.

Dr. THRESH, in his Report of 1901, p. 120, says that the place was then well supplied with water. There were seven public pumps, the wells varying from 10 to 30 ft. in depth (presumably in gravel, but possibly also in Reading Beds). His Report of 1905, p. 64, adds that three-fourths of the population got water from the public pumps, the remainder from shallow private wells. The quality is doubtful.

Chadwell Heath, see **Ilford.**

Chapel, or **Chapple** of the older map.

Ordnance Map 223, new ser. (Essex 26, NE.). Geologic Map 48, SW.

Dr. J. W. COOK's Report for 1900, repeated in Dr. THRESH's Report of 1901.

Many houses were supplied by shallow wells; some by springs which were piped to a reservoir. Several houses in the village were supplied by a well, piped to a tank on one of the houses. Some cottages were supplied by a brook, fed chiefly by the waste from this well, but partly by drainage from the railway-station.

Chelmsford.

Ordnance Map 241, new ser. (Essex 52, NE. and SE.). Geologic Map 1, SE.

1. Mr. Baker's, Chemist, High Street. Now part of Bond's Draper's Store.

From Sir J. PRESTWICH's MS. and note from A. C. VELEY, 1853.

81 ft. above Ordnance Datum.

250 ft. deep. Water at first rose to 12 ft. above the ground; but, as other wells have been made, the water-level has gradually gone down.

2. Mr. T. A. Cawley's.

Made and communicated by Messrs. ISLER & Co.

Well (the rest bored) ...		5	67 ft.
[Drift.]	Ballast [gravel]	10	
	Grey loamy sand	52	

3. Galleywood. Bexfields, on the main road, north of the Common.

Information from Mr. ROLFE, the sinker, to W. H. DALTON.

Gravel	9 or 10	20 ft. or more.
Sand	1	
Blue marl	a few inches	
Brown [London] Clay	10	

The site is mapped as Boulder Clay.

4. Gray's Brewery. 1884.

Sunk 130 ft., bored 185 ft. Total 315 ft. Ends in sand.

Water-level 60 ft. down (1884). 110 ft. (1905).

At first (1884) the amount pumped only affected water-level imperceptibly, now (1905) it is pumped out in one hour. Sand comes into the bore-hole.

Chelmsford, cont.

5. Marconi's Wireless Telegraphy Co.'s New Works. (? 1912)
Made and communicated by Messrs. Isler & Co., with some information to Dr. J. C. Thresh from the Company.
About 60 ft. above sea-level.
Lined with 333 ft. of 6-in. tubes from 1 ft. down.
Water-level $105\frac{1}{2}$ ft. down. Yield, 1,400 gallons an hour, pumped for two or three days, without altering the water-level.

		Thickness. Ft.	Depth. Ft.
[Drift ?]	Sandy clay ...	6	6
	Gravel	18	24
	Brown sands ...	2	26
	Light-grey sands	19	45
[London Clay.]	Clay and chalk ...	35	80
	Blue clay ...	140	220
[Woolwich Beds and Thanet Beds.]	Loamy sands ...	15	235
	Hard sandy clay	16	251
	Green sands ...	7	258
	Sandy clay ...	22	280
	Grey sands ...	47	327
[Upper] Chalk and flints		123	450

Perhaps the 'clay and chalk' may be Boulder Clay.
For analysis of the water, see p. 372.

6. Messrs. Ridley's Flour Mills, near station. 1900.
Made and communicated by Messrs. Isler & Co.
Lined with 290 ft. of $11\frac{1}{2}$-in. tubes from 7 ft. down and with 72 ft. of 10 in. tubes from 280 ft. down.
Water-level 101 ft. down. Yield 8,000 to 10,000 gallons an hour.

		Thickness. Ft.	Depth. Ft.
Dug well		—	196
[? London Clay.]	Sand	7	203
	Blue clay ...	17	220
[? Oldhaven Beds.]	Sand and clay ...	9	229
	Pebbles	2	231
[Woolwich Beds and Thanet Beds.]	Sand and clay ...	16	247
	Mottled clay ...	7	254
	Sand and clay ...	22	276
	Blue clay ...	10	286
	Sand	31	317
	Blue clay ...	21	338
	Flints	1	339
[Upper] Chalk		42	381

Mr. Dalton had information from Mr. Purkis of an older well here, to a depth of 200 ft. into the Chalk.

7. Springfield. Three shallow wells.
Information from Mr. Rolfe, the sinker, to W. H. Dalton.
a. The Plough Inn. *b.* A quarter of a mile south-east of the church.
c. The White Hart.

	a.	*b.*	*c.*
Marl [Boulder Clay] ...	20	17	—
Sand and gravel	touched.	22	10 (gravel)
London Clay	—	touched	—

8. The Union House, on the road to Galleywood.
Information from Mr. Rolfe, the sinker, to W. H. Dalton.
Gravel 15 ft. None mapped here: perhaps a pocket only.

Chelmsford, cont.

9. Wells and Perry's Brewery. Close to railway-station. 1853.
Communicated by F. Wells.
About 85 ft. above Ordnance Datum.
Dug 155 ft., bored 185.
Rest-level of water. When bored (1853) 6 ft. down. In January, 1898, 20 ft. down.

		Thickness. Ft.	Depth. Ft.
Alluvium, etc. [? partly gravel and London Clay]		68	68
[London Clay.]	London Clay	219	287
	Clay slate	4½	291½
[Oldhaven Beds.]	Black sand	11½	303
	Sand and shingle (water met)	3	306
[? Woolwich Beds]	Grey sand	34	340

An account of an old well here, from Mr. Rolfe, the sinker, to W. H. Dalton, makes the beds above the London Clay as follows:—Gravel, 14 to 15 ft.; Blue marl, 14 to 15 ft. (? part of London Clay, but Mr. Dalton calls it old river-silt). For analysis of the water, see p. 372.

10. Messrs. Wells and Perry. A newer well. 1902.
Made and communicated by Messrs. Isler and Co.
Lined with 290 ft. of 8½-in. tubes from 4 ft. down; 80 ft. of 7¼-in. perforated, and 15 ft. of 7¼-in. plain, top 260 ft. down.
Water-level 110 ft. down.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Yellow clay	24	24
	Blue clay	4	28
	Grey sand	7	35
	Blue clay	165	200
	Clay and sand	20	220
	Claystone	1	221
	Clay and sand	13	234
[Oldhaven Beds.]	Sand and pebbles ...	7	241
[Woolwich Beds and Thanet Beds.]	Dark sand	9	250
	Shells	2	252
	Red and blue sand ...	8	260
	Blue sand	20	280
	Blue clay and sand ...	10	290
	Dark sand	56	346
[Upper.] Chalk and flints		74	420

Public Supply, Nos. 11–13.

The partial supply from Springs is noticed on pp. 74, 75.

Dr. (Sir) G. Buchanan, in his Report to the Local Government Board, 1867, pp. 157, 158, says:—"At present [1866], in addition to the chalk supply [from the Moulsham well], water is being derived from a superficial well 15 feet deep, from which, in winter, 70–80,000 gallons a day may be got, but in summer only 20–25,000. This water is very hard, and is delivered alternately with the soft water; printed notices to the townspeople telling them on which days they may expect the one or the other. This supplementary source of supply is plainly a bad one . . . from its being exposed to all the impurities that subsoil water must necessarily encounter."

According to the Water Works Directory, 1911, the population supplied was 17,800. The district of supply is Chelmsford and the parish of Widford. The sources of supply are wells and borings, Mildmay Road and Burgess Hill [? shallow well and springs], and springs from Admiral's Park. The Springfield Ward is supplied from the Great Baddow Works of the Rural District Council (see pp. 77, 166). The supply for the year ended 30 September, 1910, was 8,237,010 gallons.

The supply taken for Springfield averaged 71,000 gallons a day in July, 1913, according to P. T. Harrison.

Chelmsford, cont.

11. Moulsham (The Mildmay Well). For the Local Board of Health, 1853.

Communicated by the Surveyor to the Board. Further constructive particulars from Messrs. EASTON and ANDERSON and from Dr. NEWTON.

83 ft. above Ordnance Datum.

Sunk 205 ft., the rest bored. A tunnel 120 ft. down. Shaft since filled up about 60 ft. by sand from below. 2 boreholes, one only to 360 ft. Only a little water comes from the deeper bore-hole. The two give identical waters analytically.

Water overflowed at first (1853), but, now the well is in use and pumped from, the water only rises to 76 ft. from the surface (1888). 95 ft. down in 1898. Yield about 95,000 gallons a day of good soft water; appears to vary; only 75,000 in 1895.

			Thickness. Ft.	Depth. Ft.
Black soil (mould)*			3	3
[Drift, 63½ ft.]	Yellow clay		2½	5½
	Gravel*		12½	18
	Quicksand*		44½	62½
	Sand with stones		4	66½
[London Clay, 186½ ft. ?]	Clay		104	170½
	Clay with sand		50	220½
	Dark sand		12½	233
	Clay slate [? septaria]		¾	233¾
	Clay and shells		4	237¾
	Clay slate [? septaria]		¼	238
	Dark sand and clay		9½	247½
	[Basement-bed ?]	Sand and shells	4	251½
		Pebbles	1½	253
[Woolwich Beds (and part of the Thanet Sand ?) 83 ft.]	Sand		7	260
	Red clay		12	272
	Clay and sand		64	336
Dark [Thanet] sand			30	366
[Upper Chalk] 202 ft.	Chalk		88	454
	Rubble		1	455
	Chalk*		113	568

* The section given by Dr. R. J. REECE in his Report to the Local Government Board of 1896 differs in details of the beds marked.* Soil 2½ ft., Gravel 12 ft., Quicksand 44 ft., Chalk 115 ft., with corresponding slight differences in the depths.

The Trial-bore noticed by Prof. PRESTWICH (*Quart. Journ. Geol. Soc.*, vol. x, p. 154), was not carried further than the sand below the pebbles, and differs from this section in the following matters of detail:—

The Drift is given thus:—

Yellow clay ...	1	67 ft.
Gravel ...	15	
Dark sand ...	51	

The uppermost part of the London Clay is given as 100 ft.

The 4-ft. bed of 'Clay and shells' is given as 'Clay and sand.'

Instead of the 'Sand with shells,' doubtfully classed as 'Basement-bed of the London Clay,' the following beds are given thus:

Clay sand and shells ...	2½ ft.
Clay	½ ft.

H. B. WOODWARD told me that he had seen some specimens from this well in the Chelmsford Museum. The note accompanying them differed slightly from both of the above accounts.

For analyses of the water, see pp. 370, 371 (from both boreholes).

According to P. T. HARRISON (paper read to Inst. Munic. Eng., 1914), the average daily yield of the Mildmay Borehole in July, 1913, was 125,000 gallons. The borehole has been overhauled recently and the sand removed.

Chelmsford, cont.

12. Moulsham. Waterworks well of 1901.

Communicated by Mr. Sasse.

Close to the old well (known as No. 8). No. 11 of this Memoir.

83 ft. above Ordnance Datum.

Water-level 75 ft. down (1901).

Yield: 7,000 to 8,000 gallons an hour pumped continuously for a week, the water-level falling to 200 ft. down.

		Thickness. Ft.	Depth. Ft.
Superficial deposits		62	62
[London Clay.]	London Clay	103	165
	Clay and sand	52	217
[Lower London Tertiaries.]	Dark sand	14	231
	Sand-rock	$\frac{3}{4}$	$231\frac{3}{4}$
	Clay and shells	4	$235\frac{3}{4}$
	Dark sand	10	$245\frac{3}{4}$
	Sand and shells	5	$250\frac{3}{4}$
	Pebbles	1	$251\frac{3}{4}$
	Sand	7	$258\frac{3}{4}$
	Red clay	12	$270\frac{3}{4}$
	Dark clay and sand	66	$336\frac{3}{4}$
	Thanet sand	$27\frac{1}{2}$	$364\frac{1}{4}$
[Upper] Chalk		$297\frac{3}{4}$	662

For analysis of the water, see p. 371.

13. New Pumping Station, on the eastern side of the road, about 1,000 yds. north of the church on Galleywood Common.

Paper read to Inst. Munic. County Eng., 1914, by P. T. Harrison.

Trial-boring, of 9-in. diameter, made in 1912. Test-pumping showed a yield of between 5,000 and 6,000 gallons an hour [from Lower London Tertiaries].

Second boring, 10 ft. off, made in 1913. Lined with steel tubes of 14-in. inside diameter for 400 ft. and then with perforated tubes of 12-in. diameter for 134 ft.

		Thickness. Ft.	Depth. Ft.
Soil		1	1
Gravel		15	16
[London Clay, 394 ft.]	Red brickearth	3	19
	Blue clay, with thin beds of rock [septaria] 5 shown on plate	204	223
	Brownish clay	83	306
	Grey clay slate [shaley clay]	9	315
	Hard grey clay and slate [shaley clay]	95	410
[Oldhaven Beds, 18 ft.]	Hard dry sand	7	417
	Sand and water, with pebbles	11	428
[Reading Beds, and Thanet Beds, $106\frac{1}{2}$ ft.]	Dark clay	2	430
	Dry sand, clay and shingle (sandy clay on plate)	$10\frac{1}{2}$	$440\frac{1}{2}$
	Greenish mottled clay	$4\frac{1}{2}$	445
	Hard green sand and clay, with water (on plate the lower half is described as grey sand)	39	484
	Dark clayey silt	2	486
	Fine grey sand and sandstone	48	534
	Flints	$\frac{1}{2}$	$534\frac{1}{2}$
[Upper] Chalk		$5\frac{1}{2}$	540

Chelmsford, cont.

Some notes I made of specimens from the first boring differ from the above and give rather more detail, and therefore are given below, with the depths at which the specimens were found, in feet.

	? Basement of London Clay: grey clayey sand (sand-rock)	410
[Oldhaven Beds.]	Black flint pebbles (? *Cyprina*) ...	417
	Fine pale sand	420
	Clayey sand ?	424
	Black flint-pebbles, shells	425
	Fine clayey sand	426
	Black flint-pebbles, a foot	428
[Woolwich and Reading Beds.]	Dark sandy clay or loam	430
	Grey sandy clay	434
	More shelly sandy clay...	439
	Sandy clay	440, 445
	Pale greenish clayey sand	447
	Fine grey sand	460
	Sand and shells	465

Dr. THRESH said, in 1912, that the (first) boring yielded about 100,000 gallons a day of good water. For analysis, see p. 372.

Chelmsford Rural District Council.

'Water Works Directory,' 1911.

See **Danbury** (pp. 76, 77), **Great Baddow** (pp. 77, 166), **Great Waltham** (p. 78), **Ingatestone** (pp. 78, 200, 201), and **Writtle** p. 320).

The total population supplied comes to 12,680. The areas supplied are noted under each place.

Chesterford, see Great and Little Chesterford.

Chignal St. James.

Ordnance Map 240, new ser. (Essex 43, SW., SE.). Geologic Map 1, NE.

Mr. M. Christy's. Between Broomwood and Beaumont Otes Farm. July, 1911.

Communicated by MILLER CHRISTY.

Plenty of water.

	Thickness. Ft.	Depth. Ft.
Top soil and mild clay	6	6
Chalky boulder clay	4	10
Reddish clay with stones	20	30
Sharp white sand and gravel ...	2	32
Clean stones and shingle	4	36

Chignal civil parish, including the two ecclesiastical parishes, Chignal Smealy and Chignal St. James, is supplied by one of the several springs by wells and by brooks. The spring-water and well-water mostly good. One group of cottages was dependent on a ditch or pond, the water of which was much polluted. In 1897 a public well was made, which yielded good water.

Chigwell.

Ordnance Map 257, new ser. (Essex 65, NE., 66, NW.). Geologic Map 1, NW.

Grange Hill.

Dr. J. MITCHELL'S MSS., vol. iii, opp. p. 72, and Sir J. PRESTWICH'S MS.

Dug 228 ft.; bored 70 ft.

Water abundant; rose to about 160 ft. from the surface.

Stiff clay, almost all blue	296	298 ft.
[Reading Beds] Mottled clay, to sand...	2	

Childerditch.

Ordnance Map 257, new ser., but not marked thereon (Essex 67, SE., 75, NE.). Geologic Map 1, SW. and SE.

Information obtained by H. W. BRISTOW from J. DARBY.

The greatest depth between Bulphan and Thorndon Hall is through—

[London Clay]	Chocolate-coloured clay ...	40	180 ft.
	Blue clay	about 120	
	Mixture of blue clay and pebbles	20	

According to Dr. THRESH's Report of 1901, p. 82, Childerditch Street was supplied by a deep well, the property of LORD PETRE. The remaining houses in Childerditch had shallow wells. The supply was somewhat deficient in the summer.

In 1905 only a few houses were connected with the mains of the South Essex Co., which now supplies the place.

Chingford.

Ordnance Map 256, new ser. (Essex 65, NW.). Geologic Maps 1, NW., and London District, Sheet 2.

1. Chingford Mill. East London Waterworks Company (now Metropolitan Water Board). 1885.

Communicated by W. B. BRYAN, the Company's Engineer; and from Messrs. DOCWRA.

38 ft. above Ordnance Datum.

Cylinder and shaft 50 ft.; the rest bored (3 ft. to 2 ft. diameter).

Water rose from the bore to 5 ft. 1 in. above the surface. Water-level, in July, 1885, 2 to 3 in. below the surface. Yield about 500,000 gallons a day [? from the bore-hole, close by].

		Thickness. Ft.	Depth. Ft.
[River] Gravel	... ...	10	10
[London Clay, 54 ft.]	Blue clay	$44\frac{1}{2}$	$54\frac{1}{2}$
	Sandy clay	$7\frac{1}{2}$	62
	Black pebbles [basement-bed] ...	2	64
[Reading Beds, $41\frac{1}{2}$ ft.]	Sand	$4\frac{1}{2}$	$68\frac{1}{2}$
	Mottled clay	3	$71\frac{1}{2}$
	White sand	11	$82\frac{1}{2}$
	Dark sand	$7\frac{1}{2}$	90
	Pebbles	1	91
	Dark sand	$10\frac{1}{2}$	$101\frac{1}{2}$
	Black pebbles	4	$105\frac{1}{2}$
[Thanet Sand, 36 ft.]	Dark sand	35	$140\frac{1}{2}$
	Flints	1	$141\frac{1}{2}$
[Upper.] Chalk. Beds of flints at 236 ft. deep (6 in.), at 243 (6 in.), at 249 (10 in.), and at 296 (4 in.). At 306 very hard chalk (for 4 ft. down), at 336 very soft chalk, at 385 very hard chalk and flints, at 404 hard chalk and flints (for 42 ft. down)		$309\frac{1}{2}$	451

For an analysis of the water, see p. 373.

2. Holly House, King's Head Hill. After 1874.

Communicated by A. SHELDON.

About 90 ft. above Ordnance Datum.

Shaft 80 ft. Bored 80 or 85 ft.

Water rose to within 40 ft. of the surface.

London Clay, pale bluish or slate-coloured. The last 10 ft. through blue, brown, and yellow mottled clay into sand and black [flint] pebbles [? Basement-bed].

Chingford, cont.

3. The 'Bull and Crown.' Old well.

Communicated by Mr. T. Hay Wilson.

About 170 ft. above Ordnance Datum. Said to be 275 ft. deep, and always with about 30 ft. of water, which was soft, and probably therefore not from the Chalk.

This well supplied the neighbouring part of Chingford, until the East London Company's water was laid on.

Chrishall.

Ordnance Map 205, new ser. (Essex 2, SW., 8, NW.). Geologic Map 47.

1. Broad Green. Trial-boring. 1884.

Made and communicated by Mr. G. Ingold.

432 ft. above Ordnance Datum.

Water in small quantities.

[Glacial Drift]	Yellow clay	3	25 ft.
	Blue clay	5	
	Loose rubbly chalk ...	$1\frac{1}{2}$	
	Blue clay	$15\frac{1}{2}$	

2. Chrishall Green. 1883.

Sunk and communicated by Mr. G. Ingold.

Trial-boring. No water.

[Glacial Drift]	Red sandy loam ...	5	72 ft.
	Blue boulder clay ...	67	

3. Crawley End. Trial-boring. 1884.

Made and communicated by Mr. G. Ingold.

424 ft. above Ordnance Datum.

Water in small quantities.

[Glacial Drift]	Dark brown clay ...	13	25 ft.
	Loose rubbly chalk ...	2	
	Blue clay	10	

4. Near the schools. Trial-boring. 1884.

Made and communicated by Mr. G. Ingold.

432 ft. above Ordnance Datum.

Good spring.

[Glacial Drift]	Yellow clay	6	25 ft.
	Blue clay	3	
	Loose rubbly chalk ...	2	
	Blue clay	14	

According to Dr. Thresh's Report of 1901, p. 143, there were six public pumps, supplied from springs or ponds.

Clacton-on-Sea.

Ordnance Map 242, new ser. (Essex 48, NW.). Geologic Map 48, SW.

1. Waterworks, on the western side of the road nearly half a mile southward of Magdalen Green, and north of Clapgate (? trial-boring). 1878.

Sunk and communicated by Mr. T. Tilley, and from specimens shown me by him.

About 50 ft. above high-water mark. Water brackish.

Clacton, cont.

		Thickness. Ft.	Depth. Ft.
Soil (brown loam)		2	2
[Post-Glacial Drift, 18 ft.]	Brown and grey sandy clay	5	7
	Gravel	5	12
	Whitish sand, with flints	1	13
	Brown sand	5	18
	Conglomerate and gravel	2	20
[London Clay, 170 ft.]	Dark grey clay	136	156
	Dark brown sandy clay, with water	10	166
	Brown clayey sand, with water	14	180
	Grey shelly clay	2	182
	Grey and buff clay	8	190
[London Clay, or Reading Beds, 24 ft.]	Light-brown clay (mottled)	7	197
	Brown mottled clay	2	199
	Dark brown sand and clay	3	202
	Brown sand (partly clayey)	12	214
[Reading Beds, 56 ft.]	Brown and light-green sand	6	220
	Red and green mottled clayey sand	2	222
	Green-grey clay	14	236
	Dark brownish-grey clay and sand	20	256
	Black and green sand	10	266
	Green clayey sand	2	268
	Green clayey sand, with flints	2	270
[Upper.] Chalk		20	290

There is some doubt as to the division between the London Clay and the Reading Beds. The original account, moreover, makes the depth to the Chalk 268 ft., the lowest bed of green sand (with flints) having been added from a specimen marked 270 ft.

2. Waterworks. Newer well. 1883.

With additional information on the first well given by J. Church.

Mr. Church's account of the first well differs somewhat from the above (which may be only of a trial-boring), and as it will be useful to compare this account of the first well (1880, 1881) with that of the newer one (1883), I give the two side by side, all the information being from Mr. Church.

The shaft of the older well has been carried down to 120 ft., and the water-level is 45 ft. down. The two wells are 16 ft. apart.

In the older well the water was brackish at 203 ft.; but after deepening the bore to 405 ft. good water rose. It became salt later and the well was abandoned.

The first sand-spring occurred at a depth of 157 ft., the second at 202. A good supply was got at 210 ft., although charged with sand.

The yield of the second well was tested as far as the pumps allowed, up to 100 gallons a minute. Analysis showed the water to be of good quality, with only 4·9 grains of chlorides to a gallon.

<table>
<tr><th></th><th></th><th>1880, 81.</th><th>1883.</th></tr>
<tr><td>Soil</td><td></td><td colspan="2">2</td></tr>
<tr><td>[Post Glacial Drift, 19½ ft.]</td><td>Yellow loam</td><td colspan="2">4</td></tr>
<tr><td></td><td>Yellow clay</td><td colspan="2">1½</td></tr>
<tr><td></td><td>Yellow gravel</td><td colspan="2">2</td></tr>
<tr><td></td><td>Yellow sand</td><td colspan="2">8½</td></tr>
<tr><td></td><td>Hard brown gravel</td><td colspan="2">3</td></tr>
<tr><td></td><td>Black gravel</td><td colspan="2">½</td></tr>
<tr><td>[London Clay, 158½ ft.]</td><td>Blue clay</td><td colspan="2">132½</td></tr>
<tr><td></td><td>Dark sand and water</td><td colspan="2">18</td></tr>
<tr><td></td><td>Dark green dead sand</td><td colspan="2">4</td></tr>
<tr><td></td><td>Large dark pebbles [black flint]</td><td>¾</td><td>½</td></tr>
<tr><td></td><td>Blue shelly clay</td><td>3¼</td><td>3½</td></tr>
</table>

Clacton, cont.

		1880, 81.	1883.	
[Indeterminable. London Clay or Reading Beds, ? 30 ft.]	Blue and brown clay	4		
	Mottled clay (brown, 1880) ...	5		
	Dark clay	7		
	Light-coloured clay	6	14	Light-coloured clay.
	Light-coloured fine sand ...	3		
	Light-green sand	5		
[Reading Beds, ? 53½ ft.]	Dark sandy clay	9	13½	Light-coloured sand.
	Red and green sandy clay ...	3		
	Green mottled clay	1		
	Green clay	13	1½	Hard dark clay.
	Silty clay	19	39	Coloured [mottled] clays.
	Dark green sandy clay ...	8		
	Green flints	½		
	To Chalk ...	263½	264	to flints over the Chalk.
[Upper Chalk.]	Soft Chalk (no flints)	128½		
	Chalk and flints	158		
		550	352 nearly.	

An account given to Dr. Thresh by the Water Co. makes the level of the works 50 ft. above Ordnance Datum, the water-level 50 ft. down, the thickness of the Gravel and Sand 25 ft. and the depth to the Chalk 288. The site is amidst houses. The yield very little and the water gets brackish with pumping.

3. Waterworks. Shallow well in Watson's Land, in a field behind the water-tower. The trench is piped to the central well.

Water-level 10 ft. down. All in gravel.

According to the Water Works Directory, 1911, p. 90, the works were bought by the local authority in 1899; the population supplied was 10,000; the daily consumption per head was 22 gallons; the area supplied, Clacton-on-Sea and Great Clacton; the wells are in gravel and chalk.

For an analysis of the water, see p. 374.

A supply is now taken from springs at Great Bentley, see pp. 77, 78.

See also **Great Bentley** and **Little Clacton.**

Clavering.

Ordnance Map 222, new ser. (Essex 13, NW., NE.). Geologic Map 47.

1. Hill Green. ? Public well. 1896.

Made and communicated by Mr. G. Ingold.

320 ft. above Ordnance Datum.

Water at 98 ft. (? 103 ft. down in 1912.)

Blue Boulder clay ...	48	105 ft.
Chalk	57	

2. The Bowers. 1897.

Made and communicated by Mr. G. Ingold.

About 290 ft. above O.D.

Water 60 ft. down. Slow spring.

Clavering, cont.

		Thickness. Ft.	Depth. Ft.
Soil	... ...	1	1
[Glacial Drift.]	Hard gravel	6	7
	Loose gravel	1	8
	Hard gravel	6	14
	Brown loam	4	18
	Gravel with large stones	9	27
	Brown clay and gravel	7	34
Chalk	... ...	31¾	65¾

A large cavity was found just outside the well, extending back about 4 ft., with a depth of 10 or 12 ft., in the gravel and clay just above the Chalk.

Information from W. H. Mumford in 1912 gives the depth as 75 ft., the yield as 25 gallons a day and the age of the well as about 25 years. For analysis of the water, see p. 375.

3. The Hall. 1889.

Made and communicated by Mr. G. Ingold.

Water-level 82 ft. down.

Drift.	Brown clay ...	5	85 ft.
Chalk	... ...	80	

According to the Report of the Medical Officer (W. Armistead) for 1912, there were four public pumps, one on Hill Green (No. 1 above ?). One is at a new well (1912) at Sheepcote Green, about 370 ft. above Ordnance Datum, the water-level about 244 ft., shaft 135 ft., bored 20 ft. One in Middle Street is supplied from a spring. One on Stickling Green is supplied from a well in Boulder Clay [? to gravel.]

There are now (1913) five public wells, three getting their water from springs in the gravel.

Claybury, see **Ilford.**

Coggeshall.

Ordnance Map 223, new ser. (Essex 26, SW.). Geologic Map 47.

Dr. W. W. Fletcher. Report to the Local Government Board, No. 244, 1906, pp. 3, 4.

"There are many private wells . . but the majority of the inhabitants obtain water from St. Peter's Well. This is an excavation . . not far from the church. . . . Unquestionably the well is fed by an ample spring, or perhaps by more than one, but I am unable to speak as to the quality of the water. . . Another public water supply is a pump about the centre of a space . . just in front of 'The Yorkshire Grey Inn.' . . . A third public supply is by the side of the main road . . to Colchester, beyond the limits of the village proper. It appears to be derived from a spring or springs in higher ground near at hand."

"At the Brewery, Little Coggeshall Parish, but practically in Coggeshall Village, there is an artesian well and boring. . . The water rises sufficiently high to serve standpipes. On analysis this water is said to have proved satisfactory."

See also under Spring Supplies, p. 75.

1. Boring for the Braintree Rural District Council. Field at the Church Street corner of Dead Lane, 275 yds. south-east of church. 1908.

Communicated by E. E. Turner and by Messrs. Sands and Walker.

112·35 ft. above Ordnance Datum.

A boring of 9-in. internal diameter to 295 ft. down, all lined.

A good supply of water found between 350 and 420 ft. Rose to less than 19 ft. down (1908). 14 days' pumping, at the rate of 6,500 gallons an hour, lowered it to 35 ft. down. The original level regained in five minutes on

Coggeshall, cont.

pumping being stopped. Pumping at the rate of 10,000 gallons an hour reduced the level to 47 ft. down.

		Thickness. Ft.	Depth. Ft.
[Drift.]	Yellow clay and chalk stones ...	7	7
	Brown sand	1	8
	Live grey sand	27	35
	Blue clay and chalk stones ...	33	68
	Clay and pebbles	4	72
[London Clay, 83 ft.]	London Clay	36	108
	Dead sand	14	122
	Rock	1	123
	Dead sand	11	134
	Rock	2	136
	Dead sand	19	155
[Reading and ? Thanet Beds, 100 ft.]	Mottled clay	30	185
	Coloured sand	11	196
	Grey sand	44	240
	Brown sand	10	250
	Green sand	4	254
	Flints	1	255
[Upper] Chalk with flints, the first 30 to 40 ft. very soft		167	422

Messrs. SANDS and WALKER say 165 ft. in the Chalk and total depth 420 ft.
For analysis of the water, see p. 376.

2. Gravel End Brewery, Mr. J. K. King. About 1887.
Bored and communicated by Messrs. ISLER & Co.
About 100 ft. above Ordnance Datum.
Water overflowed. Minimum yield 4,000 gallons an hour.
Lined with 240 ft. of 4-in. tubes.

		Thickness. Ft.	Depth. Ft.
Work started at the bottom of a bore-hole [through Drift ? and London Clay] ...		—	110
[Reading Beds, 75 ft ?]	Dead sand	7	117
	Running sand	4	121
	Loamy sand	2	123
	Dead sand	8	131
	Pebbles and brown sand	5	136
	Brown running sand ...	16	152
	White running sand ...	3	155
	Mottled clay	5	160
	Green sand	10	170
	Grey sand	9	179
	Green sand	6	185
Grey [Thanet] sand		41	226
[Upper.] Chalk		79	305

Possibly the top five beds classed with the Reading Series may be the sandy bottom part of the London Clay.

Either there is another well or this one has been deepened to 337 ft. Water overflows 1 ft. above ground. In 1886 or 1887, when sunk, it was 2 ft. above. Yield 2,200 gallons an hour without altering head of water.

For analyses of the water, see p. 376.

3. Swinborne & Co.'s Isinglass Factory.
Information from Mr. J. HATLEY, well-sinker.
115 ft. above Ordnance Datum.
Shaft 35 ft., the rest bored. Water rose to 14 ft. below the ground.

Coggeshall, cont.

		Thickness. Ft.	Depth. Ft.
Soil	... ...	about 2	2
[London Clay ?]	Yellow clay	,, 18	20
	Blue clay	,, 130	150
	Sand (spring)	,, 5	155
	Brown clay	,, 20	175
[Reading Beds.]	Sand (spring)	,, 8	183
	Mottled grey clay ...	,, 10	193
	Greenish sand	,, 20	213
[Thanet Sand.]	Slate-coloured loam ...	,, 30	243
	Flint-gravel	,, 1	244
[Upper.] Chalk	... ...	,, 16	260

For analysis of the water, see p. 376.

According to Dr. THRESH's Report of 1905, p. 55, the few deep wells yield freely.

Colchester.

Ordnance Map 224, new ser. (Essex 27, SE., 28, SW.). Geologic Map 48, SW.

1. Castle Brewery. 1878.

Information from Mr. DANIELL and Messrs. S. F. BAKER & SONS.

Height above Ordnance Datum 80 ft.* Good supply to 65½ ft. from surface.

		Thickness. Ft.	Depth. Ft.
Made earth	... ...about	10 } 30	
[Glacial Drift.]	Sand ... ... ,,	10	30
	Gravel ... ... ,,	15	
[London Clay, 110 ft.]	Blue clay	45	75
	Plastic clay with veins of stone ...	65	140
[Woolwich and Reading Beds, 56 ft.]	Red and green sand and pebbles ...	9	149
	Hard green sand	4	153
	Grey sand	43	196
[Upper] Chalk	... ...	102	298

* Kindly levelled for the Geological Survey from a Bench-mark in High Street, by Mr. MORRIS.

A somewhat different account, from specimens and from information from Messrs. BAKER's foreman is as follows:—

		Thickness. Ft.	Depth. Ft.
Old well [gravel and London Clay] ...	... ...	60	60
[London Clay.]	Sandy clay, with bad water	12	72
	Blue clay, with claystone seams [septaria] from an inch to a foot thick	25	97
	Sand	3	100
	Hard blue clay	4½	104½
	Sand	2	106½
[Woolwich and Reading Beds (? with Thanet Beds at base)].	Mottled red and green clay	20	126½
	Sand	3	129½
	Mottled clay	24	153½
	Mottled sand	9	162½
	Dark green sand	1	163½
	Dark grey dead sand	39	202½
	Brown clay	1	203½
	Dead green sand	6	209½
	Flints, to Chalk	½ to 1	210

2. Cavalry Barracks. Infirmary stables. South of town.

Measured from a large-scale tracing in the Royal Engineers' Office.

116 ft. above sea-level.

Water rose to 94 ft. from surface.

Colchester, cont.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift, 33½ ft.]	Hard sand	22½	22½
	Loose sand		
	Very loose gravel	8	30½
	Very loose gravel, with much water ...	3	33½
[London Clay, 141½ ft.]	Yellow clay	1½	35
	Blue clay	85	120
	Hard stone in veins	3	123
	Very hard blue clay, with stones ...	13	136
	Very sandy clay, with a little water ...	3	139
	Blue clay, with veins of sand	18	157
	Blue and yellow clay, with particles of white	4	161
	Yellow and coloured clay	14	175
[Woolwich and Reading Beds, 62 ft.]	Green sand	2	177
	Dark dead sand...	6	183
	Dead sand	2	185
	Various colours [? sand]	3	188
	Dark sand, softer	3	191
	Blue clay	11	202
	Blue loamy sand, with water	34	236
	Flints	1	237
[Upper.]	Chalk, with flints	313	550

Another version of the same well, from another tracing, was as follows, but there must be a mistake as to the thick mass of gravel on the Chalk:—

	Thickness. Ft.	Depth. Ft.
Top soil	10	10
Red gravel		
Light-coloured sand and gravel ...	10	20
Dark sand and gravel...	5	25
Dark shingle, watery	6	31
Yellow shingle	1	32
Yellow clay	4	36
Blue clay	86	122
Dark gravel	115	237
Chalk	263	500

A third version in *Geol. Mag.*, vol. ii, p. 102, makes London Clay and Reading Beds together 211 ft.

An older (?) well at Colchester Barracks, 108 ft. deep in London Clay, is mentioned in Conybeare and Phillips' 'Geology of England and Wales' (1822), p. 33.

3. Eagle Brewery, East Hill. 1877.

From specimens taken at nearly every foot, and from information from H. Stopes.

30 ft. above Ordnance Datum.

Shaft 23 ft., the rest bored. An account by the owners to Dr. Thresh, 22nd March, 1898, says that the well is 'bored throughout.'

Water abundant, rising to within 18 ft. of the surface (1877).

Water-level (1898) 22½ ft. down.

Yield, tested for the first six days, 1,500,000 gallons (presumably for the whole six days).

		Thickness. Ft.	Depth. Ft.
[Post-Glacial Drift, &c., 21 ft.]	Made earth (bones, shells, &c.) ...	2	2
	Loamy brickearth	18	20
	Sandy gravel with impure water	¾ or 1	21

Colchester, cont.

		Thickness. Ft.	Depth. Ft.
[London Clay, 72 ft.]	Stiff blue clay	13	34
	Sandy clay (septaria at 42 ft.) ...	13	47
	Fine sand with water	$1\frac{1}{2}$	$48\frac{1}{2}$
	Brown sandy clay	$9\frac{1}{2}$	58
	Stiff brown and blue clay	8	66
	Septaria	1	67
	Stiff blue clay	8	75
	Stiff brownish yellow clay	2	77
	Clayey sand	3	80
	Stiff reddish brown clay, passing into	5	85
	Yellowish brown clay, passing into ...	2	87
	Blackish brown clay	2	89
	Yellowish brown clay	2	91
	Fine white quicksand ... ... Sandstone, 3 or 4 ins.	2	93
[Reading Beds, 55 ft.]	Mottled green and crimson loam ...	5	98
	Green sand	6	104
	Mottled green and crimson loam ...	2	106
	Very coarse green sand	2	108
	Mottled greenish loam	1	109
	Very coarse green sand	1	110
	Fine mottled grey and brown loam, passing into	3	113
	Dark grey sand	3	116
	Stiff dark grey clay	4	120
	Dark grey sand	2	122
	Dark grey plastic clay	1	123
	Dark grey sand	1	124
	Dark grey plastic clay	5	129
	Dark grey sand (fossil wood at 130 ft.)	11	140
	Dark grey loam	3	143
	Chocolate-coloured clay	4	147
	Dark green sand	1	148
[Thanet Beds, 6 ft.]	Pink sand	1	149
	Dark green sand	$3\frac{1}{2}$	$152\frac{1}{2}$
	Grey sand, with green coated flints ...	$1\frac{1}{2}$	154
[Upper] Chalk	... ...	43	197

According to the owners (1898) it goes 246 ft. into the Chalk, making the total depth 400 ft. An older well here is disused.

The following account of a well 'about half way down East Hill,' by the Rev. W. B. Clarke (*Trans. Geol. Soc.*, ser. 2, vol. v, p. 369) probably refers to this:—

Gravel and earth	16	82 ft.
London Clay. To sand and water ...	66	

For an analysis of the water, see p. 379.

This and another brewery (East Hill) now combined as the Colchester Brewery Co.

4. East Hill Brewery. (Charrington, Nicholls & Co.) Bored in 1888. Communicated by Messrs. Charrington, Nicholls & Co.

		Thickness. Ft.	Depth. Ft.
Made ground and clay		22	22
[London Clay.]	London Clay and stones [septaria] ...	18	40
	Sand and clay	10	50
[Reading Beds and [Thanet Beds.]	Coloured clay	36	86
	Green sand	23	109
	Black sand and clay	36	145
[Upper] Chalk		105	250

For an analysis of the water, see p. 379.

Colchester, cont.

5. Gas Works. Well and boring. (? about 1886.)
Communicated by the Manager.
13 ft. above Ordnance Datum.

Water-level 11¼ ft. down. Pumping is from the bore-tube, and continuous pumping at 2,500 gallons an hour reduces the level to 12⅓ ft. down.

The water-level has not fallen since the construction of the well (12 years, 1898). For an analysis of the water, see p. 379.

To Chalk ...	140	250 ft.
In Chalk ...	110	

6. Mile End. Essex County Asylum. About a mile north of Colchester railway-station. 1908.
Made and communicated by Messrs. ISLER & Co.
Lined with 250 ft. of 8½-in. tubes from surface.
Water-level 143 ft. down. Lowered to 212 ft. by pumping.
Yield 40,000 gallons or more a day.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Hard dark clay...	124½	124½
	Hard dark stone	2½	127
	,, ,,	11	138
[Reading Beds and Thanet Beds.]	Brown loamy sand	9	147
	Fine brown sand	14½	161½
	Very hard light-brown clay	8½	170
	Green sand	7	177
	Hard light-coloured clay and stones	24	201
	Grey sand and clay	9	210
	Dark sandy clay	26	236
	Marl	4	240
	Dark green sand	5	245
[Upper] Chalk and flints		278	523

The division between the London Clay and the Reading Beds is hard to make out: perhaps it should be fixed lower down.

For an analysis of the water, see p. 379.

7. Mile End. Keeper's Lodge at 53rd milepost on the London and Ipswich Road.

Shaft 110 ft., bore 90 ft., all in loam of varying nature [London Clay].

8. Parry's Oil Cake Mills. 1884.
Communicated by OWEN PARRY.
13 ft. above Ordnance Datum.
Water-level in 1884, 4 ft. down; in 1898, 11 ft. down.

Pumping at 3,000 gallons an hour reduces the water-level (in a 9-in. bore-hole) by 1½ ft. (1898).

*To base of clay ...	45	200 ft
Reading Beds and Thanet Beds ...	85	
Chalk ...	70	

* London Clay met with at 35 ft. Therefore only 10 ft. thick (?).

For an analysis of the water, see p. 379.

9. Sewage Farm. The Hythe. 1888.
Made and communicated by Messrs. TILLEY.

		Thickness. Ft.	Depth. Ft.
Made ground ...		10	10
Gravel ...		9	19
[London Clay.]	Loamy clay, with a foot of stone at the base ...	2	21
	Clay, with a foot of stone at the base	9	30
	Loamy clay	20	50
	Dark sand [? basement-bed] ...	5	55

Colchester, cont.

		Thickness. Ft.	Depth. Ft.
[Reading Beds, (? partly London Clay) and ? Thanet Beds.]	Dark clay	4	59
	Coloured [mottled ?] clay	19½	78½
	Fine white sand...	5	83½
	Fine green sand...	2	85½
	Strong dark clay	1	86½
	Dark green loamy sand	2	88½
	Dark green coarse sand	11½	100
	Dark loam	4	104
	Dark sand	2	106
	Strong dark loam	32	138
	Dark clay	5	143
[Upper] Chalk	... ...	75	218

For analysis of the water, see p. 379.

10. At the back of the Hospital. ? 11 ft. lower than the barracks. ? Old well.

Gravel	7	32 ft.
Sand	5	
Black clay	15	
Fine white gravel ...	1	
Black clay	4	

Public Supply (Nos. 11, 12).

The notable supply from springs has been described above (pp. 75, 76, 78, 79).

The following account of the work for getting a well-supply is also from J. M. Wood's paper, *Essex Naturalist*, 1912, vol. xvii, pp. 23, etc.

"In 1850, to supplement the then existing spring supply, the late Mr. Bruff . . . conceived the idea of sinking a well into the [London] clay, and boring through . . . into the chalk. . . ."

"Mr. Bruff's well and bore holes are still in existence, and assisted in supplying the town up till 1890, when they were put entirely out of use on account of the new well adjoining being sunk to a much greater depth, the water level being depressed when pumping below the bottom of the old well."

When "the Corporation came into possession of the water works in 1880, they immediately put down another well 30 feet (centre to centre) from Mr. Bruff's old well, but only 4 feet deeper," but with an 18-inch bore-hole down to 384 feet. "Although they obtained very little more water by this operation on account of not being able to depress the pumping level with the then existing machinery," yet the boring was valuable as it "penetrated a large and open fissure in the chalk, low down," experiments showing that it yielded water very freely.

Later the newer well was deepened "to 79 feet, from the engine house floor. The present works (except the well which was brought into use in 1891) were then constructed and completed in 1893, and continue to be the chief source of supply to the town."

11. Waterworks. At the foot of Balkern Hill, just outside the Roman Wall.

First Well. 1852.

P. Bruff, *Proc. Inst. Civ. Eng.*, vol. xix, pp. 38, 39.

Shaft 40 ft., the rest bored.

Water-level 5 ft. above high water-mark, and continued so to 1859.

According to J. M. Wood (p. 24 of his paper) on 2nd October, 1888, it was 7·66 ft. above Ordnance Datum; on 12th March, 1902, 2·78 ft. below O.D., a loss of 10·44 ft.; but 1900–1902 were dry years. On the 23rd March, 1911, it was 1·72 ft. above O.D.

Supply abundant. (1,250,000 gallons a week), from the bottom.

Colchester, cont.

		Thickness. Ft.	Depth. Ft.
Soil		6	6
[River-] Gravel		4	10
London Clay		70	80
[Reading Beds, 63 ft.]	Mottled clay	20	100
	Green sand	3	103
	Dark plastic clay	40	143
[Upper] Chalk, with flints		210	353

A different account is given in *Geol. Mag.*, vol. ii, p. 102, and in *Ann. Nat. His.*, ser. 2, vol. xiii, p. 240, as follows:—

Plenty of good water at 224 ft.

	Thickness. Ft.	Depth. Ft.
Soil and low-level gravel	12	12
London Clay, with much green sand in the lower beds	100 or 105	112 or 117
Reading Beds	30 or 25	142
Chalk, with flints	152	294

In the *Ann. Nat. Hist.* paper, J. Brown notices a number of sponges, *Foraminifera*, *Bryozoa* and *Entomostraca* from the Chalk.

In the *Geological Magazine* paper, the Rev. O. Fisher says:—"When the well was bored, the tool, after passing through a layer of flints, sank suddenly, and the water rushed up with a force that (as the late Superintendent expressed it to me) shook the hill. This shows that the spring is connected with an extensive and free reservoir. There are two other wells, at distances of a mile and a mile and a half . . east of this one, which are evidently connected with the same reservoir; for on Mondays, when the pumps are not at work at the Water-works, the water stands higher than usual in these wells."

12. Second Well. 1880?

An account was communicated by Mr. T. Tilley, and published, in the Memoir on the Country around Ipswich, in 1885. Mr. Wood, therefore, is mistaken in saying that the section is published for the first time in his paper. The two accounts differ; but Mr. Wood tells me that he was concerned with the enlarging and deepening of the well (? 1889), and, therefore the following is mainly from his description, the divisions of the Reading Beds and some other information being added from the earlier one.

Top of brickwork 35·7 ft. above Ordnance Datum.

Shaft (43 ft. originally) 79 ft. (sunk to 89, but 10 filled up with concrete), the rest bored.

Water-level 19½ ft. down in 1881, 33 ft. down in 1893, 35½ ft. in 1898.

		Thickness. Ft.	Depth. Ft.
Soil		6	6
Gravel		4	10
London Clay, 54 ft.	Blue clay	38	48
	Septaria, with water	1	49
	Dark blue loamy clay	14	63
	Dark loamy sand, with water [? Basement-bed]	1	64
Reading Beds, and? Thanet Beds, 79 ft.	Mottled clay, dry for 18 ft.	59?	123?
	Running sand	1½	124½
	Mottled clay	7½	132
	Green sand	3	135
	Plastic clay	8	143
	Flints	1	144
[Upper] Chalk		240	384

Mr. Tilley's account takes the London Clay down to 93 ft. and makes the underlying mottled clay 30 ft. thick.

Colchester, cont.

An automatic recording apparatus has been set up, so that the water-level is constantly recorded, and this has gone on for the last 23 years.

For analyses of the water, see pp. 377, 378.

The following information is from the Water Works Directory, 1911, p. 73.

Population supplied, about 45,000. Area supplied, Colchester and part of Stanway Rural District. Yearly supply, 306,727,500 gallons (? year ending 31st March, 1911). Average consumption per head for all purposes, under constant supply, 18·4 gallons.

Cold Norton.

Ordnance Map 241, new ser. (Essex 62, NW.). Geologic Map 1, NE. Purleigh Railway Station. 1887.

About 94 ft. above Ordnance Datum (9 ft. below the original surface).

Communicated by W. T. Foxlee, Resident Engineer, 'Essex Lines' (Great Eastern Railway).

Shaft 16 ft., the rest bored. Water-level 86 ft. down.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Brown clay	55	55
	Blue clay; with boulders [? broken septaria], 6 ins. thick, at 93 ft.; stones [septaria], at 158–160; stone [septaria], 6 ins. thick, at 268 and 276; Boulders [?pebbles] 15 ins., at 382?; and shells, 14 ins., at the bottom ...	334	389
[Reading Beds.]	Sand	2⅔	391⅔

An account from Messrs. Le Grand and Sutcliff differs slightly, as below:—

		Thickness. Ft. In.	Depth. Ft. In.
Shaft		—	16 0
Blue [London] clay and clay-stones...		371 10	387 10
[? Basement-bed, or Reading Beds.]	Shells ...	2 0	389 10
	Sand ...	1 8	391 6
	Stone ? ...	0 2	391 8

A note of an older well at Cold Norton, got, by W. H. Dalton, from the sinker, Mr. Hatley, agrees with the above, making the depth, through the London Clay, to sand and water, 390 ft.

Colne, see Earl's and Wakes Colne.

Colne Engaine.

Ordnance Map 223, new ser. (Essex 17). Geologic Map 47.

Mill. Information from Mr. J. Hatley, well-sinker.

Through clay to sand, 60 ft.

According to Dr. Thresh's Report of 1901, p. 120, a public well, 35 ft. deep (presumably in gravel) then yielded an unlimited supply of good water. His Report of 1905, p. 65, adds that only a small part was supplied from the public pump, most houses having wells, about 20 ft. deep.

Copford.

Ordnance Map 223, new ser. (Essex 27, NW., SW.). Geologic Map 48, SW.

Dr. J. W. Cook's Report for 1900. Repeated in Dr. Thresh's Report of 1901.

Chiefly supplied by shallow wells. The rectory gets water from a well (spring) at a little distance, the water being pumped into a tank, whence it is also piped to some houses on the Green.

Corringham.

Ordnance Map 258, new ser. (Essex 76, SE., 77, SW., 85, NW.).
Geologic Map 1, SE.

1. Tilbury Brickfields Company. About a third of a mile south-eastward of Dry Street (west of lane). 1886.

195 ft. above Ordnance Datum.

Made and communicated by R. D. BATCHELOR, of Chatham.

Shaft 180 ft.; the rest bored.

		Thickness. Ft. In.	Depth. Ft. In.
[London Clay.]	Strong yellow clay	27 0	27 0
	Blue clay, with a large quantity of septaria	341 6	368 6
	Pebbles	0 6	369 0
[? Oldhaven and Woolwich Beds.]	Live sand, with shells	50 0	419 0
[Thanet Beds, 87 ft.]	Dark sand	74 0	493 0
	Dark clay	11 0	504 0
	Dark sandy clay	1 6	505 6
	Black flints, with green clay	0 6	506 0
Chalk, 466⅓ ft.	Chalk with flints	96 0	602 0
	Chalk rock, very hard	0 6	602 6
	Chalk with flints	94 0	696 6
	Chalk rock, very hard	0 6	697 0
	Chalk with flints	23 0	720 0
	Soft chalk	25 4	745 4
	Hard chalk	20 9	766 1
	Soft chalk	9 3	775 4
	Hard chalk	10 6	785 10
	Soft chalk	57 0	842 10
	Hard tough chalk	20 4	863 2
	Chalk with flints	75 2	938 4
	Rock	0 6	938 10
	Chalk with flints	33 6	972 4

2. Mr. Wilson's.

Information from Mr. HILLS, well-sinker (from H. W. BRISTOW's Notes).
White quicksand, 10 or 12 ft.

3. Thames Haven. The Thames Haven Co., Cattle Landing Station.

On the marsh and about 450 yds. from the river. 1879.

Made by Messrs. S. F. BAKER and SONS.

W. B. KINSEY, in *Iron*, 1879, vol. xiv, pp. 422, 423, and *Trans. Sanitary Inst.*, vol. i, 1880, p. 203.

Water overflowed. When the boring was $78\frac{1}{4}$ ft. down the water-level was $5\frac{1}{2}$ ft. down; at $122\frac{1}{2}$, $6\frac{1}{3}$ ft. down; at 200, $4\frac{2}{3}$ ft. down (salt to the taste); at 274, it rose and fell with the tide from 6 in. above ground to 6 in. below and a powerful pump drew Thanet Sand into the boring through fissures in the chalk. Plugging the fissures with cement caused a rise in water-level; at 360 ft. the water was $11\frac{1}{2}$ in. above ground at high-water, and 520 gallons an hour was pumped at 100 ft. down; at 460 and 502 ft. water from flint-veins raised the level to 14 in. above ground at high-water, the yield at 100 ft. down being 1,300 gallons an hour in the case of the veins at 460 ft., and 2,200 gallons an hour in the case of those at 502 ft. Final water-level (boring then 572 ft. deep), 19 in. above ground at high tide and 7 in. below at low tide. Hard pumping reduced the water-level to about 100 ft. down.

Daily supply 26,000 gallons, but much more could be got (1879).

Corringham, cont.

		Thickness. Ft. In.	Depth. Ft. In.
[Alluvium, 50¾ ft.]	Light-brown clay	16 0	16 0
	Peat	2 6	18 6
	Soft ooze...	4 2	22 8
	Grey sand	25 10	48 6
	Grey clay, stones, and shells, with thin veins of black greasy sand ...	2 3	50 9
[Valley Gravel]	Sand and stones (about 3½in. diameter) forming a dark gravel	27 6	78 3
[? London Clay, 40¼ ft.]	Stiff, dark brown clay	28 9	107 0
	Sand and clay in veins...	5 10	112 10
	Sandy clay and shells	1 2	114 0
	Sandy clay	1 6	115 6
	Sandy clay and pebbles	3 0	118 6
[? Oldhaven Beds, 5¼ ft.]	Light-coloured running sand, with water	4 0	122 6
	Sand and oyster-shells	1 3	123 9
[Woolwich and Reading Beds, 33¼ ft.]	Dark sand, with shell-fragments ...	9 3	133 0
	Yellow, ochreous, sandy clay	3 0	136 0
	Greenish sandy clay	9 0	145 0
	Fine, green, light-coloured sands, firm and dry	10 0	155 0
	Dark sand and pebbles, with fragments of shells	2 0	157 0
[Thanet Beds, 111½ ft.]	Fine greenish sand: top 9 ft. full of water; more solid and close at 170 ft. deep; very hard and dry at 180 ft.; the bottom 40 ft. with water	76 0	233 0
	Greenish clayey sand; plastic at 246 ft. deep; at 253 ft. dry and firm; at 256 ft. looser; at 259 to 262 ft. bands of hard, dry, sandy clay; the bottom 6 ft. more or less rotten sand and clay	35 0	268 0
	Green-coated flints	0 6	268 6
Chalk:	marly from 308 to 355 ft. deep; with flint water-bearing veins at 360 ft.; greyish and firm at 367; hard and white at 426; hard at 440; soft, with flints and water-veins, at 460; darker and harder at 475; flint-veins full of water at 502; grey and water-less at 506½; white, with flints and water, at 521; grey, without water, at 529; soft, with cavities, flint-veins further apart but full of water, at 536; hard and dark 540–545 [? Chalk Rock]; softer and whiter at 550; white and marly 566–572	303 6	572 0

It is difficult to make out the subdivisions of the Lower London Tertiaries.

For analyses of the water at various stages, see p. 380.

An account of the older well here; got from the sinker (Mr. PURKIS) by W. H. DALTON, differs much; but being from memory only can hardly be trusted in details. It makes Alluvium 22 ft., Gravel 25, Clays (with a little sand) 185, or 232 to sand and water.

Temperatures of the water at various depths.

When the boring was 370 ft. deep, water from 20 ft. down 54° F., from 72 ft. 55° F., and from 100 ft. 56° F., these tests extending over 3 days [one for each depth?] and the air-temperature falling from 50° F. on the first to 34° F. on the third.

When the boring was 521 ft. deep, water from 20 ft. down 56° F., from 72 ft. 58° F., from 100 ft. 58° F.

When the boring was 572 ft. deep (air-temperature 80° F. in the shade), the water temperatures were the same as when 521 ft. deep, possibly because the largest supply was from 536 ft.

Corringham, cont.

In the old well (when 130 ft. deep), water 8 ft. down, 51° F. with air-temperature 50° F.

In the new well (*i.e.*, the 572 ft. boring here noted). The water from 198 ft. down after 5 minutes' pumping was 54° F., and after 3 hours' pumping, 58° F., air-temperature being 50° and water-level at the commencement 12 in. above ground.

After a rest of 18 hours, air-temperature being 46° F. in the shade and that of the river at high tide being 48° F. :—The water in the old well was 48° F. (the water-level being $7\frac{1}{2}$ ft. down) [? Temperature of water taken at water-level.] The water of new well $2\frac{1}{2}$ ft. above ground (at a testing-cock) stand-pipes and pumps having been emptied to that level, 46° :

After working pump a sufficient portion of a stroke to empty it of all water above 12 in. above ground (at which point the water would overflow if free), 50°. The other temperatures remained as in previous tests.

4. Thames Haven. Messrs. Seabrook & Sons. Public House, about $\frac{1}{4}$ mile westward of the cattle-landing station. 1898.

Made and communicated by Messrs. Isler & Co.

Lined with 75 ft. of $7\frac{1}{4}$-in. tubes, from surface; and with 320 ft. of 4-in. tubes from 2 ft. down. Water-level 3 ft. down at first. In 1915, 46 ft. down, rising with the tide to within 6 ft. of surface. Analysis, p. 380.

		Thickness. Ft.	In.	Depth. Ft.	In.
[Alluvium.]	Marsh surface	4	6	4	6
	Light-brown clay	9	7	14	1
	Peat	3	0	17	1
	Soft ooze...	10	8	27	9
[River Drift.]	Grey sand	27	3	55	0
	Grey claystones and sand ...	1	6	56	6
	Sandstone and dark gravel ...	30	0	86	6
[? London Clay.]	Clay	27	0	113	6
	Sand and clay in veins ...	4	6	118	0
	Sand clay and shell	2	0	120	0
	Sand clay	1	6	121	6
	Sand clay and pebbles	3	0	124	6
[Oldhaven Beds, Woolwich Beds and Thanet Beds.]	Running light-coloured sand ...	4	6	129	0
	Sand and oyster-shells	1	0	130	0
	Dark sand and shells	12	6	142	6
	Sandy clay	4	0	146	6
	Greenish sandy clay	11	0	157	6
	Fine green light-coloured sand	11	6	169	0
	Fine greenish sands	61	0	230	0
	Greenish clayey sands	19	0	249	0
	Green-coated flints	1	3	250	3
[Upper Chalk.]	Hard white chalk	80	9	331	0
	Chalk and flints	69	0	400	0

5. Kynoch's Works. Borley House. On the Marsh, by the side of Hole Haven Creek. 1898. See **Stanford,** p. 267.

Communicated by the Manager. Sunk by Messrs. Batchelor.

Water-level 3 ft. down. Yield 200,000 gallons a day (1898).

Clay	12	700 ft.
Sand and gravel ...	238	
Chalk	450	

Had to be taken to that depth to get the requisite yield.

There seems to be some error here. There must be London Clay and Lower London Tertiaries in the 238 ft. An account of an old well at Borley House makes the depth to the base of the London Clay 250 ft., which is too high.

For analysis of the water, see p. 391.

According to Dr. Thresh's Report of 1905, p. 27, 75 per cent. of the supply then came from the South Essex Co., and 15 per cent. from private wells. There was one public well about 50 ft. deep.

Creeksea or Cricksea (see also **Canewdon**, p. 111).

Ordnance Map 258, new ser., but not marked thereon, just west of Burnham (Essex 63, SE.). Geologic Map 2.

According to Dr. THRESH's Report of 1905, p. 40, the public well was shallow and of very limited yield. There were one or two deep wells supplying private houses. One of these is at the Hall.

The water-mains from Burnham have recently been extended to supply this village. (1912.)

Dagenham.

Ordnance Map 257, new ser. (Essex 66, S.W, 74). Geologic Maps, 1, SW., and London District, Sheet 2.

1. Chadwell Heath? "Between Chadwell Street and the turnpike-gate near the 10-mile-stone on the road from Romford to London."

Dr. J. MITCHELL's MSS. ? vol. iii, p. 72.

Dug 45 ft., the rest bored. Good supply of water.

Blue [London] Clay, to sand and black pebbles, 100 ft.

2. Chadwell Heath. Rose Lane. Mr. Oldaker's. 1878.

About 100 ft. above Ordnance Datum.

Made and communicated by Messrs. LE GRAND and SUTCLIFF.

Bored throughout. Water-level 86 ft. down. Supply 1,200 gallons a day.

		Thickness. Ft.	In.	Depth. Ft.	In.
[London Clay.]	Blue clay	42	0	42	0
	Brownish clay	27	0	69	0
	Blue clay	42	0	111	0
	Sand and blue sandy clay ...	18	0	129	0
	Blue sandy clay and stone ...	9	6	138	6
[? Woolwich and Reading Beds, 27 ft.]	Grey and green sand	7	2	145	8
	Live grey sand	4	0	149	8
	Blue sandy clay and shells ...	3	4	153	0
	Dead green sand	12	6	165	6
[? Thanet Sand, or Reading Beds, 30½ ft.]	Grey sand	4	6	170	0
	Dead green sand	15	6	185	6
	Dead grey sand	10	6	196	0

(This may be in Ilford.)

3. Messrs. Samuel Williams & Sons. Near the Dock Railway Station. 1909.

Two wells, 30 ft. apart.

One [? No. 2, or West Well] a 6-in. bore-hole. Bored and communicated by Messrs. R. RICHARDS.

5 ft. above Ordnance Datum.

Water-level 6½ ft. down, lowered to 15 ft. down by pumping at the rate of 1,200 gallons an hour.

In 1911 the rest-level 8 ft. down.

Yield of the two wells, 5,000 gallons an hour. (See also section 4.)

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Earth	4	4
	Peat	16	20
	Green sand and clay	2	22
[River Drift.]	Sand and gravel	22½	44½
Thanet Sand.	Thanet ? sand*	79½	124
	Stones [green-coated flints] ...	½	124½
[Upper Chalk.]	Soft chalk	72½	197
	Flints	1½	198½
	Chalk	23½	222
	Flints	1	223
	Chalk	2	225

* Exactly like Thanet Sand but did not rise in the tubes. [The thickness seems too great, however, and probably some Woolwich Beds is included.]

Dagenham, cont.

4. Messrs. WILLIAMS. No. 1, or East Well, 30 ft. from the former. Near Dagenham Dock Station. Now (Sept., 1911) used for Thames Ironworks.

Communicated by A. E. WILLIAMS.

5 ft. above Ordnance Datum.

Water-level 8 ft. down.

Yield No. 1, 2,250 gallons an hour } Sept., 1911
,, No. 2, 2,700 ,, ,, }

	Thickness. Ft.	Depth. Ft.
Top soil...	3	3
[Alluvium] ... Peat	15	18
[River Gravel.] Ballast	24	42
[? Woolwich Beds and Thanet Beds] Clayey sand ...	95	137
[Upper.] Chalk	85	222

For an analysis of the water, see p. 381.

About 100 houses in Dagenham depended on shallow wells. Dr. THRESH. Report of 1901, p. 68.

In the Geology of London, etc., vol. ii, a well was wrongly entered as at Dagenham Hall. It should have been Dagnams, see Noak Hill, p. 232.

Danbury.

Ordnance Map 241, new ser. (Essex 53). Geologic Map 1, NE.
Two old wells. Information from Mr. PURKIS, the sinker, to W. H. DALTON.

1. Coleham Lane. Admiral Johnson's. Gravel, 28 ft.
2. St. Clere's. Gravel, 65 ft. [? excessive].

Debden.

Ordnance Map 222, new ser. (Essex 9, SW., 14). Geologic Map 47.

Nos. 1 to 6. Made and communicated by Mr. G INGOLD.

1. Mr. Ambrose's Cottages. 1886.
Shaft 60 ft., the rest bored. Water-level 52 ft. down.

2. Dean's Farm. 1889.

			Thickness. Ft.	Depth. Ft.
Glacial Drift.]	[Boulder Clay.]	Brown clay	5	5
		Rubbly chalk	3	8
		Blue clay, with a thin layer of sand at 17 ft.	38	46
		Blue sandy clay ...	6	52
		Blue clay	20½	72½
		Brown clay	1	73½
	Gravel		3½	77
	Sand		2	79
	Brown sandy loam		3	82
	Sharp red sand		15	97
Chalk			92	189

3 Debden, or Smith's, Green. South-east of the village. 1886.
Shaft 25 ft., the rest bored. A little water at 25 ft.

[Boulder Clay.] { Brown clay ... 12 } 46 ft.
{ Blue clay ... 34 }

Two other wells here. [The first may be No. 1.]

[Boulder Clay.] { Dark brown clay 12 and 12 ft.
{ Blue clay ... 77 ,, 34 ,,

Debden, cont.

4. Godfrey's Farm. 1885.
Shaft 48 ft., the rest bored. Water-level 77 ft. down [?].

	Thickness. Ft.	Depth. Ft.
Blue boulder clay	48	48
Yellow clay	11	59
Sand	18	77

5. Monk's Farm, 1886.
Shaft 20 ft., the rest bored. No water.
Blue Boulder Clay ... 49 ft.

6. Wych Bass Farm. 1885.
Water near surface.

[Boulder Clay.]	Brown and blue clay ...	17	20 ft.
	Loose chalky rubble ...	3	

The Medical Officer (W. Armistead), says (1913), that the public well on Debden Green is only 18 to 20 ft. deep, and that another public well in the centre of the vilage is 35 ft. deep.

7. Debden Cross boring for proposed South Essex Water Board, just W. of the cross-roads. 1900.
Made by T. W. Wood. Communicated by Messrs. Rofe.
337·21 ft. above Ordnance Datum.
Chalk water-level 82 ft. down.

		Thickness. Ft.	Depth. Ft.
Soil and thin bed of gravel		2	2
[Glacial Drift.]	Boulder clay	126	128
	Grey sand	7	135
	Grey sand and pebbles	3	138
	Coarse pebbly conglomerate	9	147
	Coarse grey sand and pebbles ...	3	150
	Coarse light-brown sand and pebbles...	15	165
	Brown sand without pebbles	10	175
	Green sand	26	201
[Reading Beds, 60 ft. ?]	Dark brown sand with small pebbles and mottled clays	35	236
	Mottled brown clay	8½	244½
	White mottled clay	13½	258
	Green running sand	3	261
[Upper Chalk.]	Soft chalk with few flints	39	300

It is hard to make out the division between the Drift and the Reading Beds: 60 ft. seems too great a thickness for the latter hereabouts. At any rate there is a very great thickness of Drift, much more than would have been expected, though much less than in the deep channel of Drift at Newport, etc. (see pp. 64, 65).

Dedham.

Ordnance Map 224, new ser. (Essex 19). Geologic Map 48, NW.

1. Mr. Downes', near the Lamb Inn.
Rev. W. B. Clarke, *Trans. Geol. Soc.*, ser. 2, vol. v., p. 372. (1840.)

		Thickness. Ft.	Depth. Ft.
Earth [soil]		1½	1½
[Post Glacial (River) Drift.]	Gravel	1	2½
	Brown clay ...	5	7½
	Gravel	1	8½
	Red sand ...	1¼	9¾
	Dark grey sand	¼	10
	Gravel ...	¼	10¼
Blue London Clay		10	20¼

Dedham, cont.

2. Grammar School. 1885.

Boring, made and communicated by Messrs. S. F. Baker and Son.
About 100 ft. above Ordnance Datum.
Water rose to 6 ft. from the surface.
Serves a public pump in the street.

		Thickness. Ft.	Depth. Ft.
	[Turf and mould	$3\frac{1}{2}$	$3\frac{1}{2}$
	Ballast [gravel] with water	$8\frac{1}{2}$	12
[London Clay, $4\frac{3}{4}$ ft.]	Sand and loam	2	14
	Brown clay	1	15
	Blue clay	$1\frac{3}{4}$	$16\frac{3}{4}$
[Reading Beds, $64\frac{1}{2}$ ft.; the bottom $4\frac{3}{4}$ ft. may be Thanet Beds.]	Light-coloured sand	$3\frac{3}{4}$	$20\frac{1}{2}$
	Coloured [mottled] clay	7	$27\frac{1}{2}$
	Light-coloured sand	5	$32\frac{1}{2}$
	Grey sand, with water	$\frac{1}{2}$	33
	Light-coloured sand	4	37
	Grey sand, with water	$5\frac{1}{2}$	$42\frac{1}{2}$
	Blue clay	$1\frac{1}{4}$	$43\frac{3}{4}$
	Green sand	$4\frac{1}{4}$	48
	Blue clay	$1\frac{1}{2}$	$49\frac{1}{2}$
	Hard grey sand	$\frac{1}{2}$	50
	Hard green sand	2	52
	Blue clay	$\frac{1}{2}$	$52\frac{1}{2}$
	Hard green sand	$1\frac{1}{2}$	54
	Blue clay	16	70
	Brown loamy clay	$6\frac{1}{2}$	$76\frac{1}{2}$
	Dark loamy sand	$\frac{3}{4}$	$77\frac{1}{4}$
	Dark grey sand, with water	$2\frac{3}{4}$	80
	Blue sandy clay...	$\frac{1}{2}$	$80\frac{1}{2}$
	Flints	$\frac{3}{4}$	$81\frac{1}{4}$
	[Upper] Chalk... about	90	171

Perhaps the top bed of sand may be the basement-bed of the London Clay.
For analysis of the water, see p. 382.

3. Wells at Pig Lane.

Rev. W. B. Clarke, *Trans. Geol. Soc.*, ser. 2, vol. v., p. 372. (1840.)
Surface beds from 16 to 60 ft.
London Clay ,, 28 ,, 37 ,,

4. Lower Park House.

About 66 ft. above Ordnance Datum.
At the edge of the London Clay.
Water enough for a small mansion-supply.
Clay pierced at 25 ft. and then sunk a further 10 ft. in sand.
For analysis, see p. 382.

5. Tendring Hundred Water Co. New well.

$\frac{1}{4}$ mile north of boundary of Lower Park, in a field at west side of main road from Dedham to Ardleigh Heath. 1912.
Made and communicated by Messrs. Batchelor.
Some notes from H. Miller.
25 ft. above Ordnance Datum.
Yield tested to 15,000 gallons an hour.

		Thickness. Ft.	Ins.	Depth. Ft.	Ins.
	Soil	1	0	1	0
[? River Drift.]	Brown loamy sand	2	0	3	0
	Gravel and loam	6	3	9	3
	Sharp whitish sand	2	9	12	0
	Red sand and gravel	8	6	20	6
	Grey sand	12	8	33	2
[? Reading Beds.]	Blue clay	7	10	41	0
	Thanet sand	8	6	49	6
	Clayey sand ($28\frac{1}{2}$ according to Mr. Miller)	28	0	77	6
	[Upper] Chalk ...	323	6	401	0

Dedham, cont.

This section is hard to make out. Perhaps the sands below the gravel do not belong to the Drift, but to the Lower London Tertiaries. The Blue Clay, however, may be London Clay, and if so, that formation is not far separated from the Chalk.

For analysis of the water, see p. 382.

Dr. J. W. Cook's Report for 1900 (repeated in Dr. Thresh's Report of 1901), says that shallow wells abound. The inhabitants had access to the well at the Grammar School. The general supply in the village was not satisfactory. At Stonylands (west of village) two or three wells had recently been made, about 45 ft. deep.

Dengie.

Ordnance Map 242, new ser. Geologic Map 2.

Shrill, Dengie Marshes. Old well.

Information from Mr. Hatley, the sinker, to W. H. Dalton.

Mud [Alluvium]	15	275 ft.
London Clay, to sand and water ...	260	

Water got chiefly from shallow wells (in gravel) some showing signs of pollution. There were also a few bored wells (Dr. Thresh's Report of 1901, p. 109), but according to Report of 1905 their water was falling and the yield lessening.

Donyland, East and West, see Rowhedge and Berechurch.

Dovercourt.

Ordnance Map 224, new ser. (Essex 21). Geologic Map 48, NE.

1. Waterworks. Close to the edge of the Marsh south of the village.

From specimens at the Waterworks; some that are doubtful have their descriptions enclosed in brackets.

Shaft 27 ft., the rest bored.

Water close to the surface; is pumped down 17 ft.; supply abundant.

			Ft.
[London Clay, 37 ft. or more.]		Light-grey sandy clay	at 20
		Brown loam (with pyrites ?)	,, 26
	[Basement-bed.]	(Buff Sand)	,, 30
		(Light-brown or buff sand, a flint pebble)	,, 31
		(Buff sand with a little clay and small nodules of race) ...	,, 36
		(Clayey sand with very small calcareous nodules or race, almost a pisolite)	,, 37
[Reading Beds, about 50 ft.]		(Grey mottled clay)	,, 40
		(Buff sand)	,, 42
		Brown and grey clay	,, 43
		Brown sandy clay or clayey sand	,, 45
		(Brown clay) depth not marked	
		Light-brown sandy clay or clayey sand ...	,, 56
		Light-brown clay	,, 60
		Brown clay ... ... (and	,, 68 below)
		Brown clay, mottled grey	at 77
		Grey clay	,, 79
		Red and green mottled sandy clay	,, 84
		Red and green mottled sandy clay or clayey sand. There is an unmarked specimen with green-coated flints	,, 86
Chalk		... ... from	88 to 393
		Total depth given as	400

Dovercourt, cont.

2. Waterworks. A later well. 1882.

Made and communicated by Messrs. Tilley.

		Thickness. Ft.	Depth. Ft.
Well, and brick-bottom (3 ft.)	...	—	30
[London Clay.]	Sand and clay ...	7	37
	Hard stone ... nearly	$2\frac{1}{2}$	$39\frac{1}{2}$
	Clay ...	5	$44\frac{1}{2}$
[Reading Beds, $43\frac{1}{2}$ ft.]	Plastic clay ...	32	$76\frac{1}{2}$
	Sand and water ...	1	$77\frac{1}{2}$
	Mottled clay ... over	$9\frac{1}{2}$	87
	Green sand and flints ...	1	88
[? Upper and Middle Chalk.]	Chalk, with flints at 183, $203\frac{1}{2}$, $213\frac{3}{4}$, $222\frac{1}{4}$, 233, 249, $269\frac{1}{4}$, $284\frac{1}{2}$, 315, $332\frac{1}{2}$, $348\frac{3}{4}$, $358\frac{1}{3}$, 364, $367\frac{2}{3}$, over 419, $439\frac{2}{3}$ and at the base ...	$352\frac{1}{4}$	$440\frac{1}{4}$
	Hard chalk ...	62	$502\frac{1}{4}$

These works have been taken over by the Tendring Hundred Water Co., and abandoned.

For an analysis of the water from these works, see p. 383.

In 1901 the houses in Upper Dovercourt were not connected with the mains of the Tendring Hundred Co., but now they are (1913).

Downham.

Ordnance Map 258, new ser. (Essex 60, SE., 61, SW., 68, NW., 69, NE.). Geologic Map 1, NE.

Dr. Thresh's Report on the Water Supply of Essex, 1901, p. 82.

Population then about 300. There was no public well yielding water fit for drinking. Some inhabitants used a private pump. Others got water from a well in Wickford. The remainder had to use pond-water.

The place is now in the area of the Southend Water Co.

Southend Water Co.'s Downham or No. 20 Well. $1\frac{1}{2}$ miles NW. of Wickford Church. 1909.

Communicated by E. C. Bilham, Engineer to the Company.

71 ft. above Ordnance Datum.

Sunk portion 372 ft. 45 and 28-in. tubes to $422\frac{3}{4}$.

Highest water-level 88·75 ft. down. Lowest (pumping) 383.

		Thickness. Ft.	In.	Depth. Ft	In.
Soil...	...	1	0	1	0
[London Clay.]	Brown clay and stones ...	1	0	2	0
	Tough yellow clay ...	4	0	6	0
	Brown clay and sand ...	11	0	17	0
	Brown clay, jointy ...	4	0	21	0
	Darker and tougher clay ...	4	0	25	0
	Blue clay ...	0	6	25	6
	London clay, very jointy at $269\frac{3}{4}$. Clay nodules [septaria] at 370 ft ...	355	0	380	6
[? Oldhaven Beds and Woolwich Beds]	Sand and pebbles ...	1	3	381	9
	Very hard sand ...	11	3	393	0
	Black clay. Wood and sand	8	10	401	10
	Green sand pebbles and shells	18	11	420	9
	Green sand ...	17	3	438	0

Water from sands of Lower London Tertiaries.

Dunmow, see **Great** and **Little Dunmow.**

Dunton.

Ordnance Map 257 (Essex 76, NW., 68, SW.). Geologic Map 1, SE.

1. Mr. Willoughby's. Fryerning Hall of old map, Friern Manor of new map.
Dr. J. MITCHELL'S MSS., vol. iii, p. 76.
100 ft. dug; the rest bored.

Water rose within 77 ft. of the surface; contains sulphate of magnesia.

[London Clay.]	Yellow clay	25
	Blue clay, with selenite, pyrites, and wood...	319
	To 'water-rock' ...	344

2. Rectory.

Information from Dr. CARTER, M.O.H. of Billericay Rural District.
Well dug 100 feet and bored 200 more. Water very hard.

According to Dr. THRESH'S Report on the Water Supply of Essex, 1901, p. 83, there was no public supply; there were a number of shallow wells in Lower Dunton and two deep wells in the parish. Some of the farms were very badly off for water.

Earls Colne.

Ordnance Map 223, new ser. (Essex 17, SW., SE., 26, NW., NE.).
Geologic Map 47.

1. Messrs. Hunt & Co.'s. Atlas Ironworks. Over a quarter of a mile westward of the church. 1877?.

Communicated by D. R. SHARPE, of Braintree.

About 186 ft. above Ordnance Datum.

Shaft about 86 ft., the rest bored.

Water rose to 80 ft. down. Later it stood in the morning about 87 ft. down, and sank from $7\frac{1}{2}$ to 8 ft. after pumping ten hours, at the rate of 950 gallons an hour. Supply abundant.

		Thickness. Ft.	Depth. Ft.
Old well [Gravel and London Clay]		—	86
[London Clay.]	Blue or London Clay, with clay-stone at 128 to 129	56	142
	Grey loamy sand	23	165
	Bagshot pebbles [flint pebbles of basement-bed]	2	167
[Reading Beds, 38 ft.]	Brown clay	8	175
	Coloured [mottled] clay, with stones	4	179
	Yellow clay	4	183
	Pink clay	7	190
	Grey sand	5	195
	Green sand	3	198
	Coloured [mottled] loamy sand ...	3	201
	Green sand	4	205
[Thanet Beds, 38 ft.]	Grey sand	33	238
	Dead green sand	$4\frac{1}{2}$	$242\frac{1}{2}$
	Pebbles. Green flints	$\frac{1}{2}$	243
[Upper] Chalk	... ...	107	350

For analysis of the water, see p. 384.

An earlier account, from specimens at the office, and from information given there, and by Mr. PURKIS (well-sinker), was published in the Memoir on Sheet 47. Messrs. HUNT write, however (1914), that these particulars of the old well and bore are hardly trustworthy. They were thought to be correct at the time, but accurate measurements were not then taken as they are now. When the earthquake occurred in 1883 (see p. 65), the bore-pipe, in the centre of the well, was squeezed up, and they could not clear it or get any water: so another bore was made in the same well, just on one side. The old account, however, gives the additional information that 14 feet of gravel occurred above the London Clay.

Earls Colne, cont.

2. Waterworks. George Lane. 500 yds. south of Colneford Bridge (? about ¾ mile south-east of church). 1912.

Communicated by Messrs. SANDS and WALKER.

About 90 ft. above Ordnance Datum.

A 10⅝-in. boring.

Very little water obtainable from the Thanet Sands, which water rose to within 12 ft. of the surface; the maximum amount of it obtainable was 400 gallons an hour, getting which lowered the level by 50 ft.

Chalk water-level 6 ft. 10 in. down. Now (Sept., 1912) pumping at over 5,000 gallons an hour and level only reduced by 12 ft. Yield 8,000 later.

		Thickness. Ft.	Depth. Ft.
[Drift.]	Silt	1	1
	Red silty clay	4	5
	Rough red gravel	4	9
	Dark clay and pebbles	1	10
	Greenish clay	2½	12½
	Rough flinty gravel	6½	19
[London Clay, 58½ ft. ?]	Dark silty clay	4	23
	Green mottled clay	3	26
	Wet silty loamy clay	16	42
	Septaria stone bed and water	1	43
	Tough London Clay	7	50
	Silty mottled clay	8	58
	Septaria stone bed	½	58½
	Silty mottled clay	3½	62
	Grey loamy sand	14	76
	Bagshot [flint] pebbles	1½	77½
[Lower London Tertiaries.]	Brown clay	2½	80
	Pink clay	2	82
	Grey sand	3	85
	Brown clay	7	92
	Reddish clay	15	107
	Reddish sand	4	111
	Very tough red and green sandy mottled clay	3	114
	Hard green sand	9	123
	Dark grey sand and water	29	152
	Vary hard coloured [mottled] sandy clay	8	160
	Hard green sand	5	165
[Upper Chalk]	Soft chalk-rock and water	100	265

For analysis of the water, see p. 487.

According to Dr. THRESH's Reports of 1901, p. 120, and of 1905, p. 60, Mr. Hunt supplied most of his cottages from the well at the ironworks, and also pumped water into a tank in the main street, from which water could be taken free, and this was the chief supply of the town. The rest of the parish depended on many private shallow wells, some known to be polluted; so that seven or eight houses often fetched water from one well: this supply was indifferent.

H. O. CROSS (Sanitary Inspector) says (1913) that on Colne Ford Hill there is a public supply from a well 16 ft. deep, yielding 1,200 gallons a day.

East Donyland, see **Rowhedge.**

Easter, see **High Easter.**

East Ham.

Ordnance Map 257, new ser. (Essex 73, SE., 81, NE.). Geologic Maps 1, SW., and London District, Sheet 2.

1. East Ham Level. Beckton Gas Works. Westward of the main works, and about 850 ft. from the Thames. 1869.

[This is a part of the Thames marshes, which, although on the northern side of the river, really belongs to Kent.]

East Ham, cont.

Communicated by J. PITTER.
Shaft about 25 ft., the rest bored.
Water oozes in to about 2 ft. from the top.

		Thickness. Ft.	Depth. Ft.
[Soil] top sand		1	1
[Alluvium.]	Clay	3	4
	Mud	2	6
	Peat	13	19
Gravel [? including Blackheath pebble-beds]		51	70
[Woolwich Beds.]	Silty sand	7	77
	Pudding-stone	$\frac{2}{3}$	$77\frac{2}{3}$
[Thanet Sand, $39\frac{1}{3}$ ft.]	Silty sand	$2\frac{1}{3}$	80
	Sand	20	100
	Dead sand	$16\frac{1}{2}$	$116\frac{1}{2}$
	Flints	$\frac{1}{2}$	117
[Upper] Chalk		83	200

An account in the 'Kentish Independent,' No. 2043, 23rd June, 1882, makes the depth to the Chalk 108 ft.

2. Beckton Gas Works. Second well. 1,877 yds. north-west of the older well, west of East Ham Manor Way and south of the Great Sewer. 1887.

Communicated by C. J. ALFORD, from the examination of specimens. (Words in these brackets from G. C. TREWBY, Engineer to the Gas Light and Coke Co.)

(Water rose to within 4 ft. 8 in. of the surface, in June, 1887: in 1888 it stood at 6 ft. Brought down to $69\frac{1}{2}$ ft., by pumping about 480 gallons an hour.)

		Thickness. Ft.	Depth. Ft.
Soil		4	4
[Alluvium.]	Peat	4	8
	Sandy clay	2	10
[River Drift, 13 ft.]	Gravel, the bottom 2 ft. red	12	22
	Loamy gravel	1	23
[London Clay, 43 ft.]	Loam	1	24
	Blue clay	24	48
	Brown clay with shells	5	53
	Shell-bed [*Aporrhais Sowerbyi* and *Rostellaria lucida ?*—in cement-stone]	2	55
	Clay, shells, and pebbles	5	60
	Blue clay and large pebbles	6	66
[Woolwich Beds, 38 ft.]	Blue clay	1	67
	Clay with shells	3	70
	Clay, shells, and (yellow) sand	5	75
	Clay with shells	3	78
	Clay, shells, and sand	1	79
	Blue marly clay, (yellow sand) with shells	6	85
	Hard blue clay (grey rock)	1	86
	(Clay, sand and pebbles)	2	88
	(Sand and large pebbles)	2	90
	Loamy green sand	10	100
	Green sand with pebbles	4	104
[Thanet Sand, 53 ft.]	Grey and brown (and black) sands	48	152
	Sand, with black rolled [?] flints (9 ins.)	5	157
To Chalk			

For analyses of water from the Beckton Gas Works wells see p. 385.
An analysis of water from a deep trench, for a sewer, is given on p. 384.

For details of the following East Ham wells see the Memoir on London Wells, by G. BARROW, 1912, pp. 93-98. There are differences in the classification.

East Ham, cont.

3. Beckton Gas Works. No. 1 at Tar Works. 1905.
About 10 ft. above Ordnance Datum.
Yield 1,700 gallons an hour.

	Thickness. Ft.	Depth. Ft.
Made ground, Alluvium and River Gravel	42¼	42 §
London Clay	16¼	58½
Woolwich Beds and Thanet Sand	90	148½
Upper Chalk	351½	500

4. Beckton Gas Works. No. 2 at Gas Works. 1906.
10 ft. above Ordnance Datum.
Water-level 24 ft. below Ordnance Datum. Supply 3,500 gallons an hour.

	Thickness. Ft.	Depth. Ft.
Made ground, Alluvium and River Drift	41	41
London Clay	29	70
? Blackheath Beds, Woolwich Beds and Thanet Sand	103	173
Upper Chalk	227	400

5. Beckton Gas Works. No. 3 at Gas Works. 1906.
Water-level 28 ft. below Ordnance Datum.

	Thickness. Ft.	Depth. Ft.
Alluvium and River Gravel	70?	70
Woolwich Beds and Thanet Sand ...	86	156
Upper Chalk	244	400

6. Beckton Gas Works. No. 4 at Gas Works. 1910.
12½ ft. above Ordnance Datum.

	Thickness. Ft.	Depth. Ft.
? Alluvium and River Drift	26	26
Woolwich Beds and Thanet Sand ...	102	128
Upper Middle and Lower Chalk ...	647	775
Upper Greensand 37 ft. and Gault 163	200	975
Devonian or Old Red Sandstone ...	45	1,020

For analysis of water of No. 4, see p. 385.

7. Messrs. Burgoyne and Co. (Manufacturing Chemists).
High Street South. 1908.
10 ft. above Ordnance Datum.
Water-level 44 ft. below Ordnance Datum. Supply 2,000 gallons an hour, fallen to 1,000?

	Thickness. Ft.	Depth. Ft.
Soil and River Gravel	17	17
London Clay	59	76
? Oldhaven Beds, Woolwich Beds and Thanet Sand	104	180
Upper Chalk	122	302

For analysis of water, see p. 385.

8. Barking Road. Electric Station. 1901.
21 ft. above Ordnance Datum.
Water-level 26 ft. below Ordnance Datum. Fell to 46 in 1910.
Supply 2,500 gallons an hour, from the Chalk.

	Thickness. Ft.	Depth. Ft.
River Gravel	17	17
London Clay	45 or 51 ?	68?
Woolwich Beds and Thanet Sand ...	98 or 92	160
Upper Chalk	340	500

An analysis of water from this well appears on p. 385.

East Ham, cont.

9. Upton Park. Mellin's Food Co. 1900.

34 ft. above Ordnance Datum.

Water-level 10 ft. below Ordnance Datum. Supply 8,000 gallons an hour.

	Thickness. Ft.	Depth. Ft.
River Drift, etc.	25	25
London Clay	54	79
Woolwich Beds and Thanet Sand ...	102	181
Upper Chalk	219	400

East Hanningfield.

Ordnance Map 241, new ser. (Essex 61, NW.). Geologic Map 1. NE.
Rectory. 1791.

Gent. Mag., 1791, pt. ii, pp. 706, 707. Reproduced in *Gent. Mag. Library. English Topography*, 1893, pt. iv, p. 131, from which latter the following account is taken.

Shaft about 450 ft., then a boring of 3 in. diameter for 15 ft.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Fine light-brown imperfect marl ...	30	30
	Similar soil, with parts of a deeper colour and firmer texture; occasionally a little sand and a few shells ...	about 420	450
	Then consolidated into a rocky substance [basement-bed ?]		
	Below which, in soft soil, the tool slipped from the workman's hands and fell in up to the handle... ...	15 [or more?]	465 [or more?]

Water instantly appeared in the soft soil and rose 150 ft. within an hour, and, after a very gradual rise, now (1791) stands at 347 ft. (up the well ?). This source (bed) is supposed to supply the well at Battle Bridge, about 6 miles off and lower, where the water overflows.

According to Mr. Purkis, the upper beds were as follows, and the depth is taken from Young's 'Agriculture of Essex,' vol. i, p. 38:—

[Drift.]	Gravel and loam	25	About 500 ft.
	Brown Boulder clay... ...	...2 or 3	
London Clay	... ...	about 470	

The following additional information from Dr. Thresh:—

In 1897 the water-level was 86 ft. down. It was pumped down and the well was examined, when water was found to come in through the brickwork about 100 ft. down. The water was very hard and contained a good deal of magnesium-sulphate. It is not used for drinking purposes.

East Horndon.

Ordnance Map 242, new ser. (Essex 47). Geologic Map 48, S.W.
Geologic Map 1, SE.
Mills. An old well.
Information from the occupier to W. H. Dalton.
London Clay, 250 ft.

According to Dr. Thresh's Report on the Water Supply of Essex, 1901, p. 83, the population was 466, and the only sources of supply were ponds and shallow wells.

East Mersea.

Ordnance Map 242, new ser. (Essex 47). Geologic Map 48, SW.

1. Nearly opposite Brightlingsea. 1883.
About 3 ft. above high water-mark.
Bored and communicated by Mr. T. Tilley.
Shaft of 22 ft. ?

East Mersea, cont.

Good supply, but the water rather salt. Water-level $9\frac{1}{2}$ ft. down.
Pipes carried 7 ft. into the Chalk.

		Thickness. Ft.	Depth. Ft.
[Alluvium, 37 ft.]	Red clay	15	15
	Black silt	22	37
[? Gravel.]	Stone, with brackish water	$1\frac{1}{2}$	$38\frac{1}{2}$
	Pebbles, "supposed old beach" ...	$1\frac{1}{2}$	40
[London Clay ?]	Red clay	15	55
[Reading Beds, 60 ft.]	Green sand, very hard	30	85
	Black clay	30	115
[Upper] Chalk ...	... ...	225	340

For an analysis of the water, see p. 386.

2. In an old gravel-pit nearly a mile about east-north-east from the church and about 350 yds. from Broman's Farm. Made 1906.
W. H. Dalton, *Essex Nat.*, vol. xv, p. 136.
Depths are taken from the original surface.

Gravel ... ... about 15 ft.
Dark blue silt with shells (*Cardium edule, Scrobicularia piperata*, and *Rissoa*) ... ...

'The silt being found to be salt, the sinking was at once stopped, and measures taken to retain the fresh water yielded by the overlying gravel.'

3. Reeves Hall. Well of 10 ft. diameter and over 300 ft. deep.

For analysis of the water, see p. 386.

Dr. J. W. Cook reports that the usual supply of the parish was from shallow wells, but that there are now two Abyssinian tube-wells (1900).

Easton, see **Great Easton.**

Easton Lodge, see **Little Easton.**

East Tilbury.

Ordnance Map 271, 272, new ser. (Essex 84, SW., SE.). Geologic Map 1, SE.
According to Dr. Thresh's Reports of 1901 and 1905, p. 26, all houses were supplied from wells, averaging 60 ft. deep. Now the supply is from the South Essex Co.

East Thorpe.

Ordnance Map 223, new ser. (Essex 35, NE., 36, NW.).
Geologic Map 48, SW.
Dr. J. W. Cook's Report for 1900. Repeated in Dr. Thresh's Report of 1901, p. 134.

Shallow wells formed the chief supply. A spring in the village was guarded by concrete-work.

Eastwood.

Ordnance Map 258, new ser. (Essex 70, SW., 78, NW.). Geologic Map 1, SE.

1. Eastwood Pumping Station (or No. 3) of the Southend Water Co., half a mile a little east of south from the church. 1890.
Made and communicated by Messrs. Docwra and from E. C. Bilham, whose account shows slight differences.
$45\frac{3}{4}$ ft. above Ordnance Datum.

Cylinders and shaft (8 ft. diameter) 247 ft., the rest bored and lined to 436 ft. with 21, 18 and 13-in. pipes.

Water-level, 9th August, 1889, 100 ft. down; 25th January, 1890, 66·08 ft
Water from sand of the Lower London Tertiaries, little, if any, from the Chalk. [W. H. Dalton has noted the water-level as 90 ft., pumped down to 130.] Highest water-level recorded 66·08 ft. down. Lowest level (pumping)- 268.

Eastwood, cont.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil	...	0	9	0	9
[River Drift.]	Mixed clay, with an inch of fine sand at the base	12	3	13	0
	Brick-earth, the bottom 3 ins. mixed	12	9	25	9
	Gravel and sand	7	6	33	3
	Sharp sand	5	8	38	11
	White sand	3	7	42	6
[London Clay, 239½ ft.]	London clay	233	6	276	0
	Sandy clay	6	0	282	0
[? Blackheath Beds, 18 ft.]	Pebbles and pyrites	1	0	283	0
	Dead sand	10	0	293	0
	Pebbles and rock	1	0	294	0
	Dark sand	4	9	298	9
	Pebbles and sand	1	3	300	0
[Woolwich Beds and Thanet Beds, say 128 ft.]	Hard dark sand	33	1	333	1
	Green sand	25	2	358	3
	Blue clay	23	0	381	3
	Dark sand	18	0	399	3
	Dark clay	27	8	426	11
	Chalk flints [partly belong to Thanet Beds]	1	6	428	5
[Upper Chalk, 439 ft.]	Chalk, with a foot of flints at the base	9	2	437	7
	Chalk and flints...	13	0	450	7
	Chalk, with layers of flints at the top and at the base, and eight others, from 6 ins. (most) to a foot...	54	8	505	3
	Chalk and flint ...	17	0	522	3
	Chalk, with flints at top, at middle and at base, 6 and 9 ins thick	20	3	542	6
	Chalk and flints...	10	0	552	6
	Hard yellow chalk. On getting through this (? and to depth of 578¼ ft.) the water-level rose nearly 30½ ft.	4	0	556	6
	White sand, the bottom 4 ft. " mixed "	6	0	562	6
	Sand	0	9	563	3
	Chalk	4	6	567	9
	Sand	0	6	568	3
	Hard chalk	4	0	572	3
	Sand and shells	0	9	573	0
	Hard chalk	4	3	577	3
	Sand and chalk	1	6	578	9
	Hard chalk	4	0	582	9
	Chalk, with flints at top, and with 30 other layers of flints, from 3 to 15 ins. thick (mostly about 6 or 9)...	78	6	661	3
	Hard sandy chalk	0	9	662	0
	Hard chalk	5	3	667	3
	Rock chalk, with seven layers of flints	17	9	685	0
	Chalk	—		871	9

The occurrence of sandy beds in the Chalk is peculiar, and it is a question whether these are owing to infiltration of Tertiary Sand down joints, or whether they are merely loose gritty chalk. For analyses, see p. 386.

2. Nobles Green Pumping Station (or No. 5) of the Southend Waterwords, over three-quarters of a mile north-westward of Eastwood Church. 1896. Communicated by C. S. Bilham for the Water Works Co., and later from E. C. Bilham, with slight difference

61·75 ft. above Ordnance Datum.

Highest water-level 85 ft. down? Lowest (pumping) 383½.

Shaft, of 8 ft. diameter, 383½ ft.; the rest a bore.

Lined to 542¼ ft. with 24, 21 and 18-in. pipes. Then a 6-in. bore

Eastwood, cont.

		Thickness. Ft. In.	Depth. Ft. In.
Soil	...	1 2	1 2
[Drift, 14 ft.]	Brick-earth ...	7 0	8 2
	Sandy gravel ...	7 0	15 2
London Clay, nearly 364 ft.	London Clay, yellow ...	5 7	20 9
	London Clay, blue; Clay-nodules at frequent intervals to 157 ft. down. Large conglomerate at 68 ft. ...	358 3	379 0
[? Blackheath, Woolwich, and Thanet Beds, 148 ft.]	Sand; bottom foot very hard ...	2 6	381 6
	Shells and pebbles ...	1 6	383 0
	Dead sand, with a layer of black wood at the base ...	12 0	395 0
	Blue clay and shells ...	6 0	401 0
	Green sand and clay ...	126 0	527 0
[Upper Chalk, 329¼ ft.]	Chalk and odd flints ...	34 0	561 0
	Chalk and flints... ...	29 9	590 9
	Soft chalk ...	2 9	593 6
	Rock-chalk and beds of flints ...	23 6	617 0
	Rock-chalk ...	7 6	624 6
	Rock-chalk and beds of flints ...	30 6	655 0
	Tough chalk and beds of flints ...	97 3	752 3
	Sandy chalk and odd flints ...	31 9	784 0
	Blue marl ...	5 0	789 0
	Rock-chalk and odd flints ...	42 0	831 0
	Chalk marl ...	25 3	856 3

Water from sand of the Lower London Tertiaries. Little, if any, from the Chalk.

For an analysis of the water, see p. 388.

3. Oakwood Pumping Station (or No. 4) of the Southend Waterworks, over a third of a mile southward of Eastwood Lodge and about 2¼ miles westward of Eastwood Church. 1894.

Communicated by C. S. Bilham, for the Water Works Co.

111 ft. above Ordnance Datum.

Highest water-level before pumping was begun, 129¼ ft. down.

Lowest (pumping) 382.

Shaft, of 8 ft. diameter for 404 ft., the rest a bore. Lined to 586 ft. with 24, 21 and 18-in. pipes. Then 12-in. unlined.

		Thickness. Ft. Ins.	Depth. Ft. Ins.
Soil	...	0 6	0 6
[London Clay, 433½ ft.]	Gravelly clay ...	4 6	5 0
	Coloured clay ...	7 6	12 6
	Sandy loam ...	1 6	14 0
	Coloured clay ...	4 6	18 6
	London Clay ...	415 6	434 0
[? Blackheath, Woolwich, and Thanet Beds, 147½ ft.]	Black [flint] pebbles, shells and sand...	1 6	435 6
	Dead sand ...	24 6	460 0
	Live sand ...	4 0	464 0
	Dead sand and clay ...	25 6	489 6
	Dead sand and shells ...	22 8	512 2
	Blue clay ...	25 10	538 0
	Blue clay and sand ...	43 5	581 5
	Green flints ...	0 3	581 8
[Upper Chalk, 282¼ ft.]	Chalk with thin layers of flints ...	100 0	681 8
	Chalk ...	30 4	712 0
	Chalk and flints ...	77 3	789 3
	Chalk sand and shells [? a pipe, or fallen down the bore.] ...	2 6	791 9
	Chalk and flints... ...	43 9	835 6
	Rock-chalk ...	2 3	837 9
	Hard chalk and flints ...	26 2	863 11

Total depth said to be 867½ ft. For analysis of the water, see pp. 387, 388.

Eastwood, cont.

4. Picketts Pumping Station (or No. 6). Southend Water Co. 1900.
1½ miles west-south-west from Eastwood Church.

Communicated by E. C. BILHAM, Engineer to the Co.

126·8 ft. above Ordnance Datum.

Well, 6 ft. in diameter to 352 ft., the rest bored. Lined to 513 ft. 4 ins. with 24, 21 and 18-in. pipes.

Highest water-level 235·18 ft. down. Lowest (pumping) 351.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil...		1	3	1	3
[London Clay.]	Clay and soil	1	9	3	0
	Yellow clay ...	12	6	15	6
	Yellow clay with spots of yellow	5	6	21	0
	Sand ...	5	3	26	3
	London Clay. Beds of clay nodules [septaria] at 52¼ and at 237 ft.	316	9	343	0
[Lower London Tertiaries.]	Sand and pebbles	1	0	344	0
	Hard sand	2	6	346	6
	Hard sand, pebbles and shells	24	6	371	0
	Live sand	36	3	407	3
	Sand clay and shells	12	0	419	3
	Sand and clay	76	3	495	6
	Flints	6	0	496	0
[Upper Chalk.]	Chalk...	27	3	523	3
	Chalk and flints	218	7	741	10
	Hard grey chalk	55	7	797	5

The total depth is given as 801.

Water from sand of Lower London Tertiaries. Little, if any, from the Chalk. For an analysis of the water, see p. 388.

5. Sutton Pumping Station (or No. 24) of the Southend Water Co.
About ⅝ of a mile east-south-east of Rochford Church. 1911.

Communicated by E. C. BILHAM.

22½ ft. above Ordnance Datum.

Shaft 304 ft., then unlined boring.

Highest water-level 155·5 ft. down. Lowest, 364.

		Thickness. Ft.	Ins.	Depth. Ft.	Ins.
Soil		1	0	1	0
[River Drift.]	Brick-earth	13	0	14	0
	Sand and gravel	6	0	20	0
	Yellow sand	6	2	26	2
[London Clay.]	London Clay	277	10	304	6
	,, ,, very sandy	8	0	312	6
[? Oldhaven Beds.]	Soft sand from which the water comes	13	3	325	9

Another account includes the last bed with the sandy London Clay.

For an analysis of the water, see p. 388.

6. Mr. G. Scott Miller. Belfaus. 1896.

Made and communicated by Messrs. ISLER & Co.

Lined with 551 ft. of 5-in. tubes from 1 ft. down.

Water-level in dug well 91 ft. down. In bore-hole 224 ft. down.
Yield 630 gallons an hour.

Eastwood, cont.

		Thickness. Ft.	Depth. Ft.
Dug well	...	—	178
[? London Clay.]	Blue clay ...	105	283
	Claystone ...	1	284
	Blue clay ...	49	333
	Sandy blue clay...	5	338
[? Woolwich Beds and Thanet Beds.]	Blue clay ...	40	378
	Sandy clay and pebbles ...	23	401
	Green sand ...	50	451
[Upper Chalk.]	Chalk and flints...	201	652
	Chalk ...	1	653

7. Mr. G. Wagstaffs. 1899.
Made and communicated by Messrs. Isler & Co.
Lined with 335 ft. of $7\frac{1}{4}$-in. tubes from 5 ft. down, and with 210 ft. of 6-in. tubes from 298 ft. down.
Water-level 255 ft. down. Yield 600 gallons an hour.

		Thickness. Ft.	Depth. Ft.
Dug well	...	—	14
[London Clay.]	Yellow clay ...	7	21
	Blue clay ...	397	418
[? Woolwich Beds and Thanet Beds.]	Mottled clay ...	32	450
	Green sandy clay ...	15	465
	Rock ...	2	467
	Green sandy clay ...	2	469
	Rock ...	6	475
	Green sand ...	23	498
	Black sand ...	12	510
	Green sand ...	17	527
	Black sand ...	4	531
	Green sand ...	2	533

According to Dr. Thresh's Report of 1901, p. 78, some houses in Eastwood had water from the Southend Co., but most depended on shallow wells. His Report of 1905 says that the Company supplied many houses.

Elmstead.

Ordnance Map 224, new ser. Geologic Map 48, SW.

According to Dr. Thresh's Report of 1901, p. 126, this place, with its scattered hamlets, wholly depended on shallow wells, and the supply was not too good.

Elsenham.

Ordnance Map 222, new ser. (Essex 23, NW.). Geologic Map 47.

1. Gants End. Keeper's House. 1894.
Made and communicated by G. Ingold.
Shaft $42\frac{1}{2}$ ft., the rest bored.
Water rose to within 38 ft. of the surface.

Soil	...	1	48 ft.
[Boulder Clay.]	Brown clay ...	17	
	Blue clay ...	30	

2. Gants End. Half-a-mile south of the Keeper's Lodge. 1894.
Made and communicated by G. Ingold.
Shaft throughout.
Water rose, from the bottom, to within 19 ft. of the surface.

[Boulder Clay.]	Brown clay ...	10	39 ft.
	White clay ...	10	
	Hussick (a local term for layers of loose rubbly chalk, frequently found in the Boulder Clay, and which sometimes yields a good quantity of water) ...	1	
	Blue clay ...	18	

Elsenham, cont.

3. Gants End. Sir W. Gilbey's Fruit Farm. 1892.
Shaft throughout. Made and communicated by G. Ingold.

		Thickness. Ft.	Depth. Ft.
	Brown clay ...	19	19
[Glacial Drift.]	Blue clay ...	10	29
	Loose rubble ...	4	33
	Red sand ...	1	34
	White clay ...	6	40
	Blue clay, to sand	12	52

4. Messrs. Gold's Nurseries. 1897.
298 ft. above Ordnance Datum.
Made by G. Ingold. Communicated by H. G. Featherby.
Shaft 79 ft. deep, the rest bored; tubes stand up about 4 ft. in well.
Rest-level of water, 1897, 77 ft. from surface; April, 1900, 79 ft. 9 in.
Yield tested to 3,000 gallons an hour. 1897.

		Thickness. Ft.	Depth. Ft.
Soil	... ...	1	1
[Glacial Drift.]	Brick-earth	11	12
	Light-brown clay ...	4	16
	Yellow loamy sand ...	4	20
	Gravel	11	31
	White clay	1½	32½
	Gravel	8½	41
	Yellow clay	2	43
	Gravel and sand ...	13	56
	Brown sandy loam ...	3	59
	Gravel and sand ...	24	83
	Clay and stones	3	86
[Upper] Chalk ...	... ...	115	201

5. Memorial Pump. In centre of village, near railway-station. 1896.
305 ft. above Ordnance Datum.
Made by G. Ingold. Communicated by H. G. Featherby.
Shaft 83 ft., the rest bored. Rest-level of water 80½ ft. down.

		Thickness. Ft.	Depth. Ft.
Made earth ...	... ...	3	3
[Glacial Drift.]	Gravel and sand	9	12
	Loam	2	14
	Red sandy clay	9	23
	Light-brown clay	4	27
	Dark sandy clay with black pebbles ...	1½	28½
	Grey loam	3½	32
	Light-blue clay	3	35
	Red clay	2	37
	Dark brown clay	3	40
	Light-brown sandy loam	2	42
	Blue and brown clay	2½	44½
	Yellow sandy loam	2½	47
	Dark blue clay	7	54
	Green and red clay with small pebbles	1½	55½
[? Reading Beds]	Dark green sand	1	56½
	Mottled clay	5½	62
	Light-grey sand...	2	64
	Dark sand	4	68
	Light-brown sandy loam	8	76
[Upper] Chalk	... ...	41	117

This well supplies the village. Isolated cottages get a supply from springs and wells.

Perhaps the Glacial Drift has been carried too low.

Elsenham, cont.

6. Station Road. 1894.

Made and communicated by G. INGOLD

Water from the gravel.

		Thickness. Ft.	Depth. Ft.
Soil	... ...	3	3
[Glacial Drift.]	Brown clay and stones...	4	7
	Brick-earth	4	11
	Gravel	5	16
	Sandy loam	3	19

7. The Vicarage. 1897.

288·66 ft. above Ordnance Datum.

Made by G. INGOLD. Communicated by H. G. FEATHERBY

Rest-level of water in 1897, 69 ft. down.

		Thickness. Ft.	Depth. Ft.
Made earth ...	... ...	2	2
	Grey sandy loam ...	5½	7½
	Dark sandy loam ...	2	9½
	Black sandy loam ...	8	17½
	Grey sand	4½	22
[? All Reading	Brown clay	13	35
Beds, or	Loamy sand	2	37
some Drift ?]	Dark clay	7	44
	Dark green and red clay	3	47
	Light-green sand ...	11	58
	Yellow and red loam ...	6½	64½
	Flints	½	65
[Upper] Chalk ...	... ...	45	110

Epping.

Ordnance Map 240, new ser. (Essex 50, SW.). Geologic Map 1, NW.

1. From CONYBEARE and PHILLIPS, 'Geology of England and Wales,' 1822, p. 35.

? 340 ft. above high-water-mark.

200 ft. sunk, the rest bored. Water rose to within 26 ft. of the surface.

	Thickness. Ft.	Depth. Ft.
Gravel, loam, and yellow clay	27	27
Blue clay	380	407
Alternations of sandy blue clay and blue clay ...	13	420

I take it that all but the gravel belongs to the London Clay: the loam would be the sandy top part of that formation; the yellow clay the usual discoloured uppermost part of the stiff clay; and the lowest bed the sandy bottom part.

2. Hunter's Hall, about three-quarters of a mile west of Epping Upland church.

PRESTWICH, *Quart. Journ. Geol. Soc.*, vol. x, p. 403.

To the Lower Tertiary sands (through the London Clay), 350 ft.

3. Waterworks, near the Railway Station. Now (1909) used by Epping Sanitary Steam Laundry Co. 1870.

250 ft. above Ordnance Datum.

Made and communicated by Mr. T. TILLEY.

Shaft 275 ft., the rest bored.

Slow spring. Water rose 116 ft. up the well, but after pumping stood at about 80 ft. up. Quantity of water insufficient (for the waterworks).

Epping, cont.

		Thickness. Ft.	Depth. Ft.
[Drift ?]	Red clay	10	10
	Gravel	$\frac{1}{4}$	$10\frac{1}{4}$
[London Clay, 340 ft.]	Blue clay	240	$250\frac{1}{4}$
	Sandy clay	55	$305\frac{1}{4}$
	Dark loam, very hard	30	$335\frac{1}{4}$
	Dark earth, full of shells [basement-bed ?]	15	$350\frac{1}{4}$
[? Woolwich and Reading Beds.]	Dark earth, very like peat	$2\frac{1}{2}$	$352\frac{3}{4}$
	Hard ground	$1\frac{1}{2}$	$354\frac{1}{4}$
	Hard green sand	$6\frac{1}{2}$	$360\frac{3}{4}$
	Live green sand (= quick running sand)	$5\frac{1}{2}$	$366\frac{1}{4}$

Another and later account, given by R. B. TANNER, is somewhat different, being as follows:—

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Yellow clay	7	7
	Bluish clay	$13\frac{1}{2}$	$20\frac{1}{2}$
	Blue clay	$294\frac{1}{2}$	315
[Woolwich and Reading Beds, 46 ft.]	Black sand, with stones	8	323
	Black peaty sand	1	324
	Blue clayey sand, with occasional shells	14	338
	Blue clayey sand, without shells, very stiff	17	355
	Grey sand, with loamy stripes ...	6	361
[? Thanet Sand.]	Wet sand	$41\frac{1}{2}$	$402\frac{1}{2}$
	Black flints and pebbles	$1\frac{1}{2}$	404
To Chalk			

Another account, communicated by Messrs. EASTON and ANDERSON, from particulars got from Messrs. RUSS and MINNS, is as follows:—

Shaft 225 ft., the rest bored. Water-level 210 ft. down.

	Thickness. Ft.	Depth. Ft.
River Deposits [Drift ?]	$10\frac{1}{4}$	$10\frac{1}{4}$
London Clay	$189\frac{3}{4}$	200
Woolwich and Reading Beds [must be partly London Clay]	105	305
Thanet Sand	49	354
Chalk	546?	900?

For analysis of the water, see p. 389.

4. Old Bank. Dr. Cumming.

Well 200 ft. deep.

For analysis of the water, see p. 389. Also for one from the shallow well at the Workhouse.

Fairstead.

Ordnance Map 241, new ser. (Essex 34, SW. and SE.). Geologic Map 47.
(*a*) 300 yds. SSE. of the Rectory; (*b*) Troys Hall (eastward of the Church).
Information from Mr. J. HATLEY.

	a. Ft.	*b.* Ft.
Boulder Clay	16	60
Gravel ...	—	$1\frac{1}{2}$
London Clay	260	290 or 300
To sand	276	360 ?

Fambridge.

Ordnance Map 258, new ser. (Essex 62, SW., 70, NW.)
Geologic Map 1, NE.
North Fambridge of old map. Fambridge Ferry.
Dr. J. Mitchell's MSS., vol. iii, opp. p. 80.

[London Clay.]	Yellow clay	30	362 ft.
	Blue clay	330	
	Water-rock [basement-bed?] ...	2	

The place is now supplied from the mains of the Maldon R.D.C.

Farnham.

Ordnance Map 222, new ser. (Essex 22). Geologic Map 47.

1. Perry's Farm, Farnham Green. 1892.
Made and communicated by Mr. G. Ingold [and from specimens].
Shaft throughout. Water 119½ ft. down.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift?]	White clay	3	3
	Sandy loam	2	5
	Brown sand [specimen, from 5 ft., compact, fine]	1	6
	Clay [specimen, from 15 ft., brownish, slightly mottled grey]	12	18
	Dark sand	1	19
	Yellow loamy sand	2	21
	Brown clay [specimen, from 23 ft., light-brownish and grey, sandy] ...	6	27
[Reading Beds; the lowest two beds perhaps Thanet Sand.]	Yellow and grey sand, with ironstone [specimen, from 28 ft., loose fine light-brown; and a concretion of iron-sandstone]	2	29
	Mottled clay	6	35
	Yellow sandy loam [specimens, from 35 ft., very pale fine sand, partly stained with iron; from 37 ft., crimson brown and pale sand, concreted by iron]	6	41
	Dark green loam [specimen, from 41 ft., dull green fine compact sand] ...	3½	44½
[Upper Chalk.]	Flints	½	45
	Chalk with flints [specimens, from 45 and 100 ft., soft]	78	123

Mr. Ingold suggests that the clay beginning 6 ft. down may be London Clay. If it be so that clay must rise up under the Drift, which is fairly thick on the high ground hereabouts. It is hard to make out the division between the Drift and the older Tertiary Beds.

2. The Rectory. 1893.
Made and communicated by Mr. G. Ingold.
Water-level 19 ft. down.

[Drift.]	White Boulder clay	15	23 ft.
[Drift or Reading Beds.]	Red sand ...	8	

3. Made and communicated by Mr. G. Ingold. 1888.
No water.

Boulder clay	19	47 ft.
White sand	2	
Mottled loam and sand ...	26	

According to Dr. THRESH's Report of 1905, p. 51, except for some cottages at Chatter End and part of Farnham Green, the parish was fairly supplied from wells and from a spring, with a pump. A well, 120 ft. deep, for public safety, at Farnham Green, was abandoned.

Feering.

Ordnance Map 223, new ser. (Essex 35, NE.). Geologic Map 47.

Two wells on the high road.

From the well-sinkers, to W. H. DALTON.

	Valley Gravel. Ft.	Boulder Clay to Sand. Ft.
1. Gore Pit	20	about 30
2. House at lane to village just north-east of Gore Pit. About 120 ft. above Ordnance Datum	10	... 30

3. Prested Hall, on the road up to the house and about 150 yds. from it.

Made and communicated by G. BRADDY.

Clay reached 6 ft. down and continued to 31. Not like the London Clay of the district. A specimen sent was of light-grey clay, more like Glacial brick-clay.

Dr. THRESH, in his Report of 1901, p. 116, says that in 1893 the supply was a source of anxiety. Many of the people were largely dependent on shallow surface-wells. The supply now comes from the Coggeshall Water-works.

Felsted.

Ordnance Map 222, new ser. (Essex 33, NE.). Geologic Map 47.

1. Grammar school. In the main building. Before 1880.

248 to 250 ft. above Ordnance Datum.

Communicated by Messrs. EASTON and ANDERSON, from particulars got from F. CHANCELLOR, of Chelmsford. Additional particulars from D. S. INGRAM.

Shaft of 7 and 6 ft. diameter, 180 ft., the rest bored of 8 in. diameter for 100 ft., and then of 6 in.

Water-level about 81 ft. down when sunk.

	Thickness. Ft.	Depth. Ft.
Surface-earth (shallow)		
[Glacial Drift.] Boulder clay, ? 35 or 40 ft. ? Sand and stones, irregular, 12 or 15 ft. (from which the supply was once got) ...	about 51	51
London Clay	209	260
Reading Beds (variously coloured sands, tenacious black clay with red patches, and a layer of small black flints) ...	44	304
[Upper] Chalk	100	404

For analysis of the water, see p. 390.

2. About $1\frac{1}{4}$ miles north-east of the village, near the railway-arch on the Braintree Road. 1891.

J. FRENCH, *Essex Naturalist*, vol. v, p. 205 (1891).

		Thickness. Ft.	Depth. Ft.
Glacial Drift.	Soil and Boulder Clay	5	5
	Brick-earth	1	6
	Boulder Clay, very chalky and compact	8	14
	Boulder Clay, darker, with fragments of Gault shale	2	16
	Very sandy buff clay	3	19
	Dark earth, like garden-soil, with minute fragments of flint and of chalk	2	21

According to Dr. THRESH's Report of 1901, p. 117, the village then depended on one superficial well and was badly off for water. There is now a public supply from springs, see p. 77.

Finchingfield.

Ordnance Mays 222, 223, new ser. (Essex 15, NE., the village). Geologic Map 47.

Dr. W. W. E. FLETCHER's Report (to Local Government Board), No. 244, p. 10. 1906.

"Water mainly from wells opposite the Vicarage gate, and near the Oak Inn. The latter supplies water to people living half-a-mile away, who have to carry it."

According to Dr. THRESH's Report of 1901, p. 116, the Howe Street well was a constant source of discussion (1894). Three samples of water from it were examined and all found to be polluted. There are shallow wells at some houses.

The Braintree Rural District Council has greatly improved the supply recently, and several wells have been closed.

Fobbing.

Ordnance Map 258, new ser. (Essex 76, NE., SE.). Geologic Map 1, SE.

1. Fobbing Marsh. Slated House. About 1848.

Communicated by the Inspector, Orsett Rural District.

Section supplied by Mr. FURLONG, whose father sunk the well.

8 ft. above Ordnance Datum.

Water just overflows, at about $1\frac{1}{2}$ gallons a minute (1898).

		Thickness. Ft.	Depth. Ft.
[Alluvium]	Ooze	30	30
[River Drift.]	Stiff sand	20	50
	Gravel	21	71
[? London Clay.]	Light-blue clay	5	76
	Black sand	2	78
	Shells and pebbles	2	80
[Lower London Tertiaries, 174 ft. ?]	Blowing sand	30	110
	Green sand	20	130
	Light blowing sand	70	200
	Stiff sand	40	240
	Blue clay	2	242
	Sand	7	249
	Green sands, flints and pebbles	5	254
[Upper] Chalk		22	276

Mr. SQUIER says it is a little over 300 ft. deep and goes about 30 ft. into Chalk.

The thickness of the Lower London Tertiaries seems too great; but on the other hand the lower two beds bracketed with London Clay may be Blackheath Beds.

For analysis of the water, see p. 391.

? Is this place New House of Geologic Map, or Great Ilford of the Ordnance Map.

2. South of the Church. On the marsh.

Information from I. W. SQUIER to W. H. DALTON.

Overflow regulated by the tide.

To Chalk ...	254	276 ft.
In Chalk ...	22	

According to Dr. THRESH's Report of 1905, p. 27, 10 per cent. of the supply then came from the Southend Co., whilst 75 per cent. came from private wells. There were two public wells, 12 and 16 ft. deep, with an insufficient supply.

Whilst the Company's supply is now greater, many shallow wells are still used.

Fobbing, cont.

3. Southend Water Co.'s No. 10 or Fobbing Main Well. Half a mile NW. of Fobbing Church. 1902. Deepened later.

Communicated by E. C. BILHAM, Engineer to the Company.

70 ft. above Ordnance Datum.

Sunk portion 252 ft., 32-in. bore to 315½, lined with 20-in. pipes to 313 and 20-in unlined to 756.

Highest water-level 60 ft. down. Lowest (pumping) 249.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil...	... ...	0	9	0	9
[London Clay.]	Yellow clay. Clay nodules [septaria] at 25	26	3	27	0
	Brown clay	9	0	36	0
	London Clay. Clay nodules [septaria] at 62½ and 87 ft. Damp seam at 96½. Odd clay nodules at 106. Dry and very jointy at 123½...	132	0	168	0
	London Clay and shells ...	3	0	171	0
[Lower London Tertiaries, 143½ ft.]	Pebbles	1	6	172	6
	Sand	1	6	174	0
	Sandy clay	16	1	190	1
	Black sandy clay with lumps of pyrites	4	5	194	6
	Sandy clay	39	9	234	3
	Hard dead sand	79	7	313	10
	Flints	0	8	314	6
[Upper Chalk, 336½ ft.]	Soft chalk	25	6	340	0
	Flints	0	6	340	6
	Chalk...	20	6	361	0
	Flints	0	9	361	9
	Chalk and flints	189	0	550	9
	Grey chalk and flints, very hard	28	6	579	3
	Flints and hard sandy chalk	6	0	585	3
	Flints and tough chalk ...	11	9	597	0
	Tough sticky chalk ...	5	0	602	0
	Chalk and flints	3	0	605	0
	Hard gritty chalk	3	0	608	0
	Tough chalk...	6	6	614	6
	Chalk marl	24	8	639	2
	Tough chalk, boring still in progress	—		651	0

Total depth said to be 756 ft.

Water from both Chalk and sands of Lower London Tertiaries. For analysis, see p. 391.

4. Southend Water Co.'s No. 12 or Fobbing Auxiliary Well. 400 ft. S. of the main well. 1904.

Communicated by E. C. BILHAM, Engineer to the Company.

65 ft. above Ordnance Datum.

Sunk portion 153 ft., 36-in. pipe to 243⅓, and 33-in. pipe to 316½.

Highest water-level 55 ft. down. Lowest (pumping) 351·25.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil and made ground ...	... ...	1	9	1	9
[River Drift.]	Gravel and loam	2	0	3	9
	Brick-earth	10	9	14	6
	Brick-earth and stones ...	3	0	17	6
[London Clay.]	Brown clay	4	0	21	6
	London Clay	135	10	157	4

Fobbing, cont.

		Thickness. Ft.	In.	Depth. Ft.	In.
[Lower London Tertiaries, 141 ft. ?]	Pebbles	1	6	158	10
	Sand and pebbles	3	2	162	0
	Sand	10	0	172	0
	Hard dead sand	4	0	176	0
	Sharp sand and clay ...	1	0	177	0
	Dark loamy sand	121	0	298	0
	Flints	0	6	298	6
[Upper Chalk, 252½ ft.]	Chalk...	8	0	306	6
	Hard chalk and odd flints	14	3	320	9
	Soft chalk and odd flints ...	55	9	376	6
	Tough chalk and odd flints...	93	6	469	0
	Soft chalk, marl, and flints...	46	0	515	0
	Tough chalk and flints ...	28	0	543	0
	Hard chalk and marl ...	8	0	551	0

Water from both Chalk and sands of Lower London Tertiaries. Analysis, p. 391.

5. Southend Water Co.'s No. 11 or Vange Main Well. ¾ mile SW. of Vange Church. 1904.

Communicated by E. C. Bilham, Engineer to the Company.

41 ft. above Ordnance Datum.

Highest water-level 50½ ft. down. Lowest (pumping) 208.

		Thickness. Ft.	In.	Depth. Ft.	In.
	Made ground and soil	3	0	3	0
	London Clay, sandy between 143 and 148 and sand seams at 158	231	0	234	0
[Lower London Tertiaries, 96 ft.]	Pebbles and sand	2	0	236	0
	Live sand	2	0	238	0
	Clay	2	0	240	0
	Soft sand	1	0	241	0
	Very hard sand and small pebbles	7	0	248	0
	Softer sand	1	0	249	0
	Very hard sand; pieces of shell and grit. (*Increased yield of water at* 259½) ...	12	0	261	0
	Softer sand	5	0	266	0
	Dark sandy clay	1	0	267	0
	Black plastic clay and sand	3	0	270	0
	Dark brown sand	4	6	274	6
	Nearly black sand	1	9	276	3
	Dark plastic clay and sand	1	0	277	3
	Brown coarse sand	0	9	278	0
	Lighter-coloured sharp sand (*Further increase of yield of water.*)	0	9	278	9
	Light-green sandy clay and pebbles	5	6	284	3
	Light-green clay like putty	?		?	
	Dark green sand not pierced at end of boring	—		330	0

Water from sands of the Lower London Tertiaries. For analysis, see p. 452.

6. Southend Water Co.'s Well No. 13 or Vange Auxiliary Well. 600 ft. E. of Vange Main Well. 1905.

Communicated by E. C. Bilham, Engineer to the Company.

35·75 ft. above Ordnance Datum.

Sunk portion 238, and 24-in. unlined borehole to 257 ft. 9 ins.

Highest water-level 100·75 ft. down. Lowest (pumping) 213.

Fobbing, cont.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil...		3	0	3	0
[London Clay.]	Yellow clay	16	9	19	9
	Brown clay	15	0	34	9
	Blue clay	208	0	242	9
[Oldhaven Beds ?]	Sand and pebbles	15	0	257	9

Water from sands of the Lower London Tertiaries. Analysis, p. 452.

7. Southend Water Co.'s No. 23 or Vange West Well. ¼ mile SW. of Vange Main Well. 1911.

Communicated by E. C. Bilham, Engineer to the Company.
82·5 ft. above Ordnance Datum.
Highest water-level 154 ft. down. Lowest (pumping) 251·7.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil...		1	0	1	0
London Clay		239	9	240	9
[Lower London Tertiaries, 153 ft.]	Hard sand	3	0	243	9
	Hard sand and shells	3	0	246	9
	Loose sand and lumps	2	0	248	9
	Loose sand and pebbles	5	0	253	9
	Very hard sand	2	9	256	6
	Black plastic clay and sand	13	5	269	11
	Brown coarse sand (water increased)	2	10	272	9
	Hard [? stiff] lighter-coloured clay like putty	2	0	274	9
	Green clay and sand (water further increased)	6	6	281	3
	Sharp sand	11	6	292	9
	Green sand	66	8	359	5
	Sand, darker	8	0	367	5
	Sand and clay	25	10	393	3
	Flints	0	6	393	9
[Upper] Chalk		5	0	398	9

Water from sands of the Lower London Tertiaries. Analysis, p. 452.

Fordham.

Ordnance Map 223, new ser. (Essex 18, SW., 27, NW.).
Geologic Map 48, SW.
In the centre of the parish. 1887.
Made and communicated by Mr. J. Beard, of Chapel.

[Glacial Drift, 26 ft.]	White [Boulder] clay	12	26 ft.
	Light-coloured gravel	6	
	White sand and gravel, with water	8	

The supply is wholly from shallow wells.

Forest Gate, see **West Ham.**

Foulness.

Ordnance Map 259, new ser. (Essex 71, NE. and SE. and 72).
Geologic Map 2.

According to Prestwich (MS. of 1849), the wells overflowed. According to Dr. Thresh's Report of 1901, p. 79, most of the farms had bored wells. The quality of the water was good, but the supply was limited and gradually decreasing.

1. In Gibson's Yard, about 60 ft. from the Dwelling-house.
Date of commencement, 28 July; of finish or at any rate end of the account, 7 August, 1725.

Foulness, cont.

W. H. DALTON, *Essex Naturalist*, 1908, vol. xv, pts. iv-vi, p. 120.
From an old record (1725 (?)).

First 3 ft. "dugg," the rest bored.

	Thickness. Ft.	Depth. Ft.
Hard Loom	4	4
Soft dark blue mud mix'd with sand	15	19
Brown earth mix'd with sand. "Here the ground began to founder into the Auger hole" ...	1½	20½
Soft black mud mix'd with sand	9	29½
Yellow clay mix'd with sand	1½	31
Harsh green sand	14½	35½
Yellow stiff clay with veins of rough sand... ...	1½	37
Harsh green sand	4	41
Harsh green sand mix'd with gravell and knobs of clay	5	46
Under this a thin vein of loom. From the first 5 or 6 ft. down to this depth, the salt water has risen considerably in the auger hole, and the severall stratas bor'd through have been very salt.		
Next "the said loom met with hard stones, supposed to be flints"...	1½	47½
These necessitated the use of a drill, and after 12 hours clay was reached	10	57½
". . . through a very close stiff clay of a dark blue colour, which was very fresh, and exactly agreeable to the clay that was bored through in the Well at Queenborough"	34	92 (? 91½)

Mr. DALTON says:—"The account before us gives us the fullest details on record of the composition of the alluvium. The soft dark blue and black mud, frequently flowing into the borehole, . . probably indicates the site as a point on one of the ancient creeks dividing the area. Such a creek is known to cross the churchyard along the frontage of the church; . . " He suggests that the 'Flints' (reached at about 47 feet down) at the base of the alluvial deposits are septaria or cement-stones and should be included in the London Clay.

2. For Mr. B. C. Hall. ? The Lodge Farm, east of Church End.

Made and communicated by Messrs. ISLER. 1908.

155 ft of 10-in. tubes from 4 ft. down; 263 ft. of 6-in. tubes from 3 ft. down; 380 ft. of 5-in. tubes from ground-level.

Water-level with rods in 40 and with rods out 78 ft. down, when the boring stopped at 386 ft.

When the boring was continued later, the water-level became 49 ft. down and the yield 720 gallons an hour.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Top soil	3½	3½
	Brown sand	3½	7
	Black sand	16	23
	Sand and shells (oyster and mussel) ...	21	44
[River Gravel]	Shingle	8	52
	Ballast [gravel]	18	70
[London Clay.]	London Clay, with claystone 82-83 ft. and 97-98½ ft. down...	283	353
	Black loam	7	360
	Sandy clay	13	373
[? Oldhaven Beds.]	Sand	7	380
	Loamy sand	2	382
	Sand and pebbles	2	384
	Sand	2	386

Foulness, cont.

		Thickness. Ft.	Depth. Ft.
[? Woolwich Beds.]	Blue clay and shells	5	391
	Blue clay	6	397
	Dark green sand and clay	19	416
[? Thanet Beds.]	Blue clay	34	450
	Blue clay sand	7	457
	Blue clay	45	502
[Upper.]	Chalk and flints	59	561

3. Mr. J. Hepburn's. (? Churchend.) 1909.
Made and communicated by Messrs. Isler.
Lined with 100 ft. of $7\frac{1}{4}$-in. and 370 ft. of 5-in. tubes.
Supply 1,000 gallons an hour. For an analysis of the water, see p. 392.

		Thickness. Ft.	Depth. Ft.
[? Alluvial Beds.]	Brown sand	4	4
	Dark sand	20	24
	Dark loamy sand	46	70
[London Clay.]	Brown clay	20	90
	Blue clay	268	358
	Sandy clay	13	371
[? Oldhaven Beds and Woolwich Beds.]	Dark sand (water)	$3\frac{1}{2}$	$374\frac{1}{2}$
	Dark sand and shells	$5\frac{1}{2}$	380
	Light sandstone...	10	390
	Black loamy sand	4	394
	Loamy sand and shells...	6	400
	Dark loamy sand	12	412

4. Monkenbarn (Monkton Barn of new map), WNW. of the Church. According to W. H. Dalton there is a thick bed of blue alluvial mud, full of salt water, between the soil and the sand, the latter being thinner in proportion.

5. Old Hall. East of Rectory. 1886.
W. H. Dalton. *Essex Naturalist*, 1908, vol. xv, pts. iv–vi, pp. 123, 124.
Concrete round a $7\frac{1}{2}$-in. tube from 6 to 27 ft. down; concrete round $6\frac{1}{2}$ in. tube to 50 ft. down; concrete round $5\frac{1}{2}$-in. tube to 75 ft. down. Screw-jointed $4\frac{1}{2}$-in. tube to 125 ft. down; screw-jointed $3\frac{1}{2}$-in. tube to 345 ft. down; screw-jointed ?-in. tube to 394 ft. down, the last 40 ft. perforated.

		Thickness. Ft.	Depth. Ft.
Soil		2	2
[Alluvium.]	Mixture of yellow sand and clay	5	7
	Light-coloured sand	28	35
	Black sand	8	43
	White clay	1	44
[? Gravel.]	Beach [shingle] ...	$31\frac{1}{2}$	$75\frac{1}{2}$
	Flint stone [? septaria]	$1\frac{1}{2}$	77
[London Clay.]	Clay, with 8 in. band of Loomstone [septaria] at 80 ft., and others at 159, 163, 169, and 253 ft. ...	227	304
[Lower London Tertiaries.]	Spring [presumably quicksand, Oldhaven or Woolwich Beds] ...	55	359
	Light-coloured sand and clay	11	370
	Dry hard light sand	9	379
	Green sand [Woolwich Beds] ...	2	381
	Light-coloured sand [Thanet Sand] ...	13	394
	Undescribed	3	397
	Dry green sand and clay	9	406
	Soft blue clay, like mud	12	418
	Dry green sand and clay	10	428
	Soft blue clay ...	12	440
	Blue clay and sand	7	447

From 394 ft. down was communicated by Messrs. Isler in 1909 (? from a later deepening).

Foulness, cont.

6. An older well at Old Hall.

Given to Mr. DALTON from memory in 1872 by the well-sinker, Mr. PURKIS. (From the same paper.)

		Thickness. Ft.	Depth. Ft.
[Alluvium, etc., with salt water.]	Mud, sand, etc.	20	20
	Sandy clay	15	35
	Sand	15	50
	Gravel	16	66
[London Clay and Lower London Tertiaries.]	Blue clay	350	416
	Sandy clay	50	466
	Green sand (? spring)	4	470
	Shells and pebbles	8	478

Mr. DALTON remarks that the Alluvial total (66 ft.) is practically the mean between the well of 1726 and that of 1886. He remembers that the taste of the water was unpleasant.

There is an analysis of a well-water from Old Hall, Foulness, on p. 392.

7. An account (?of another newer) well made and communicated by Mr. FURLONG is as follows:—

	Thickness. Ft.	Depth. Ft.
[Alluvium] Soil and ooze	20	20
[River Drift] Sand and gravel	90	110
London Clay	292	402
[Lower London Tertiaries.] Sandstone [firm sand] ...	9	411
[Lower London Tertiaries.] Sand	18	429

Recently deepened and used for public supply (Note of 1912).

For analysis of the water from this well, see p. 392.

Foxearth.

Ordnance Map 206, new ser. (Essex 6, NW. and SW.). Geologic Map 47.

1. The Brewery (Messrs. Ward's).

Made and communicated by Messrs. ISLER and Co.

Water-level 45 ft. down. Supply 1,200 gallons an hour.

60 ft. of 5-in. tubes from 6 ft. down and 70 ft. of 9-in. tubes.

		Thickness. Ft.	Depth. Ft.
Pit [the rest bored]		—	6
[Glacial Drift] Ballast [gravel] ...		12	18
[Glacial Drift or Eocene.]	Blue clay ...	10	28
	Mottled clay ...	19	47
	Green sand ...	15	62
Chalk		64	126

If any of the beds should turn out to be Eocene, there must be an outlier here, quite hidden under Drift.

2. Second well at the Brewery. 1899.

Also made and communicated by Messrs. ISLER and Co.

Lined with 150 ft. of 6-in. tubes.

Water-level 46 ft. down.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Yellow clay with pieces of chalk and flints	$10\frac{1}{2}$	$10\frac{1}{2}$
	Sandy gravel	8	$18\frac{1}{2}$
	Blue clay and pebbles	6	$24\frac{1}{2}$
	Blue clay and pebbles with bits of chalk	3	$27\frac{1}{2}$
	Blue clay and pebbles with bits of chalk and flints	$23\frac{1}{2}$	51
[Upper Chalk.]	Chalk	10	61
	Chalk and flints...	170	231
	Flints	$1\frac{1}{4}$	$232\frac{1}{4}$
	Chalk and flints	$36\frac{1}{4}$	$268\frac{1}{2}$

For an analysis of water from Foxearth Brewery, see p. 393.

There are several private wells. The well at the brewery yields an excellent water, and is the chief supply of the village. Ponds and springs supply outlying cottages.

Frating.

Ordnance Map 224, new ser. (Essex 28, SE. and 37, NE.).
Geologic Map 48, SW.

According to Dr. THRESH's Report of 1901, p. 126, the supply was from shallow wells (presumably in gravel), except at Frating Hall, where a ram pumped water from a brook. His Report of 1905, p. 75, notes a recent tube-well, 17 ft. deep, at the Rectory cottages.

Frinton.

Ordnance Map 224, new ser. (Essex 39, NW., SW.). Geologic Map 48, SE.
For Walton water-supply, 1879. About half a mile north-west of the church.
Communicated by P. BRUFF, C.E.
38 ft. above low water.
Shaft 51 ft. 4 in., the rest bored. Water brackish. Abandoned.

		Thickness. Ft. In.	Depth. Ft. In.
[? Drift 13 ft.]	Brickearth	6 0	6 0
	Sand	1 6	7 6
	Sandy brickearth	3 0	10 6
	Sand	2 6	13 0
[London Clay, 98 ft.]	Light-coloured clay	34 0	47 0
	Dark clay, with two layers of stone [septaria] 6 and 16 ins. thick, in lower half	64 4	111 4
[Reading Beds, 81 ft.]	Sand with pebbles*	15 0	126 4
	Red clay with sandy veins	10 0	136 4
	Plastic clay	20 0	156 4
	Black sand	1 0	157 4
	Light-coloured sand	1 0	158 4
	Plastic clay	10 0	168 4
	Red clay	2 0	170 4
	Green sand	6 0	176 4
	Clayey green sand	15 6	191 10
	Flints	0 6	192 4
[Upper] Chalk.	Two flint layers passed through	254 0	446 4

Boring said to have been continued to a depth of about 500 ft.

* This bed may be the basement-bed of the London Clay, or it may belong to the Oldhaven Beds.

Frinton is supplied by the Tendring Hundred Co.

Fryerning, see Ingatestone.

Galleywood, see Great Baddow.

Gestingthorpe.

Ordnance Map 206, new ser. (Essex 12, NW.). Geologic Map 47.

According to Dr. THRESH's Report of 1901, p. 139, there was a public well, in Chalk, supplying good water, but too far from many of the houses (near Maplestead).

Dr. J. S. HOLDEN says that another public well, on the Halstead Road, is used; but that most of the cottages get their supply from private wells.

Goldhanger.

Ordnance Map 241, new ser. (Essex 54, NE.). Geologic Map 2.
Public well in the village street about ½ mile from the sea-wall.
Information from Dr. J. C. THRESH and the Medical Officer of Health for Maldon Rural District.

Goldhanger, cont.

About 20 ft. above Ordnance Datum.
Rest-level of water 21 ft. down (1899).

Sunk 26 ft. and then a 4-in. bore to 120 ft. down. When opened (? 1898) a lot of water was found coming in at 15 ft. down.

The overflow at the top of the bore-tube (into the well) was at the rate of 90 gallons an hour (1900).

When examined (? 1898) subsoil-water was entering and the water from the bore gave different analytical results. The well has been deepened and improved since, and yields most of the domestic water.

For analyses of the water, see p. 393.

There is also a bored well at the Rectory; and several shallow wells not used for drinking purposes (Dr. THRESH's Report of 1901, p. 109).

Good Easter.

Ordnance Map 240, new ser. (Essex 42, NE., 43, NW.).
Geologic Map 47.

According to Dr. THRESH's Report of 1901, p. 102, there were two public pumps, one in the village, the other at Tye Green (N.E.). The village-pump often failed in dry weather. There were also a few private wells. The wells were about 70 ft. deep, getting water from sand, beneath Boulder Clay. Some of the outlying cottages were without supply, except from a distance or from ponds and ditches. This holds now; but the public well in the village has been deepened and bored 21 ft. (1913).

Gosfield.

Ordnance Map 223, new ser. (Essex 16 SE.). Geologic Map 47.

1. Hawkwood Farm. 1889.
Made and communicated by Mr. G. INGOLD.

[Drift.]	Brown clay ...	9	15 ft.
	Sand	5	
	Boulder clay ...	1	

2. Park Hall; a mile west of the Church.
Information from Mr. J. HATLEY.
Water rose to about 20 ft. below the surface.
Drift and London Clay, to sand and water 140 ft.

H. O. Coss (Sanitary Inspector) reported in 1913 that the supply was chiefly from private wells, with an average depth of 20 ft. No public supply.

Grays.

Ordnance Map 271, new ser. (Essex 88, SE.). Geologic Maps 1, SW. and SE.

1. Brooks, Shoobridge, and Co.'s Cement Works.
Made and communicated by Messrs. C. ISLER and Co.
Shaft 10 ft., the rest bored. Lined with 40 ft. of 8-in. tubes.
Water-level 12 ft. down. Yield 9,000 gallons an hour.

		Thickness. Ft.	Depth. Ft.
[River] Gravel	... ...	24	24
[Upper Chalk.]	Chalk	6	30
	Chalk and flints... ...	19	49
	Soft chalk	7	56
	Chalk and flints ...	15	71
	Hard chalk	5	76
	Chalk and flints ...	64	140

Grays, cont.

2. Lodge Farm, NNE. of the town, made to prove the strata. 1891.
Communicated by W. H. Radford.

The water in the old well here (disused, 87 ft. above Ordnance Datum) stands at 12·12 above Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
Soil		3	3
Gravel and sand		10	13
[Thanet Sand.]	Fine yellow sand	12	25
	Very fine white sand	22	47
[Upper] Chalk		30	77

3. Messrs. Hilton, Anderson and Brooks.
Made and communicated by Messrs. Isler.

Rest-water-level 15 ft. down; when pumping 36 ft. down. Boring unlined.

Dug well	50	150 ft.
[Upper] Chalk and flints	100	

4. Messrs. Seabrooke and Sons' Brewery and Malting. 1887.
Made and communicated by Messrs. C. Isler and Co. And from Messrs. Seabrookes.

Lined with 356 ft. of 5-in. tubes.

Tube-wells, made a few years before, to 59 ft. deep, gave an abundant supply of pure water, but, owing to the district being honeycombed with cesspools, it got contaminated; this water was practically free from salt.

On boring to 150 ft. water was found comparatively free from organic matter, but containing salt. The tubes were driven deeper and the boring continued, but the next sample yielded 3 to 4 times as much salt as the last. Above 130 ft. the water was fresh.

At 19-212 ft. down impermeable dry grey chalk, and as soon as the tubes were driven into this the upper springs were shut out. From 212-256 ft. down springs were again tapped. From 256-290 ft. down scarcely any supply was got.

The level of the water from the top springs stood at 16 ft. down, but in 1887 the water-level was 21 ft. down. Later it is given as 17 ft. Yield abundant, many springs having been struck at various depths.

White chalk with flints	283	500 ft.
,, ,, ,, ,, and with seams of grey	217	

There is an analysis of Messrs. Seabrookes' water on p. 394.

5. South Essex Water Works. 1861.

Shallow well in the Chalk Quarry south-east of Belmont Castle from which headings have been driven as follows:—

One for about 120 yds. WNW. from well, to beyond the chalk-pit.

A double set (wholly in the chalk-pit) in the other direction, meeting at a point about 240 yds. ENE. of the well.

Thence a straight one, to some way beyond the chalk-pit, for about 930 yds. E. of N., to the parish-boundary about 40 yds. west of the road.

For analyses of the water, see pp. 394, 395.

The water is now softened.

6. Training College, on the high ground about 1,300 ft. north-eastward of the railway station. No particulars of this well.

7. Grays Saltings. (Grays or Purfleet.) For Exmouth Training Ship. 1885.
Made and communicated by Messrs. Isler.

Water-level 16 ft. down. Supply 1,800 gallons an hour.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Clay	35	35
	Peat	7	42
[River Gravel] Ballast		18	60
[Upper] Chalk and flints		40	100

Great Baddow.

Ordnance Map 241, new ser. (Essex 52, SE., NE., 53, SW., NW.).
Geologic Map 1, NE.

1. Baddow Brewery Co. About 300 yds. SSE. of the church.
R. Watney. *Proc. Geol. Assoc.* 1906. vol. xix, pt. 10, p. 456.
? Old well, 316 ft., the bottom 16 filled with brick-rubbish.

		Thickness. Ft.	Depth. Ft.
Old well [through Drift and London Clay]		—	300
Broken brick rubbish		16	316
[London Clay.]	Hard clay with claystone at 326 to 327½	15	331
	[Basement-bed.] Clayey sand	1½	332½
	[Basement-bed.] Pebbles	3½	336
[? Oldhaven Beds and Reading Beds, 62 ft.]	Live sand	11	347
	Hard clay	5	352
	Pebbly sand	½	352½
	Mottled clay	6½	359
	Sand and stone	9	368
	Sand and clay	30	398
Thanet Sand		48	446
[Upper] Chalk and flints		304	750

No water in the Chalk. Water came in at 332½ to 347 and at 359 to 368.

Dr. V. H. Veley tells me that the old well was made about 1800–1810; that on 3 June, 1902, the boring became choked by the Thanet Sand coming up; that there was a similar occurrence at a similar deep well 7 miles away, the cause not having been ascertained; and that a newer boring was made in 1902–1904.

For an analysis of the water, see p. 396.

2. Boring for the Chelmsford Rural District Council. 1901.
Communicated by J. Dewhirst.
97 ft. above Ordnance Datum.
Water-level 80 ft. down, lowered to 145 ft. down by 14 days' pumping at 72,000 gallons in 24 hours.
Lined with 10-in. tubes from surface to 346 ft. down, and with 8½-in. tubes from 346 to 411.
Some water met with below the grey rock at 283½ ft. down.

		Thickness. Ft.	Depth. Ft.
Soil		2	2
[Drift.]	Yellow clay	1½	3½
	Yellow gravel	10½	14
	Red loamy sand	1	15
	Yellow gravel	12	27
	Black gravel	1½	28½
	Yellow loamy sand	1	29½
	Yellow gravel, very sandy	9½	39
[London Clay, 226½ ft.]	Brown clay	1½	40½
	Blue clay with claystone at 54 to 54½ and at 121½ to 122	225	265½
[? Oldhaven Beds and Reading Beds.]	Dark grey dead sand	16½	282
	Grey rock	1½	283½
	Dark grey dead sand	12	295½
	Black pebbles	1	296½
	Live grey sand	5	301½
	Dead sand and shells	1½	303
	Dark grey dead sand	13	316
	Mottled clay, sandy	28½	344½
[Thanet Beds.]	Dead green sand	64	408½
	Green flints	1½	410
Chalk		1	411

Great Baddow, cont.

The above is a more correct account than the version given in *Proc. Geol. Assoc.*, vol. xix, p. 455.

For an analysis of the water, see p. 396.

According to the Water Works Directory, 1911, the works were constructed in 1881 and extended in 1904: the population supplied is about 6,000: the parishes supplied are Great Baddow, part of Sandon, and the Springfield Ward of Chelmsford. The water supplied in 1910, including that from springs (see p. 77), was 31,582,000 gallons.

3. Galleywood Common. In a garden behind a cottage. Nearly the highest point of the Common. 100 yds. from the 'Eagle.'

Well in gravel and sand. Water-level 26 ft. down.

Lead poisoning suspected. For analysis of the water, see p. 396.

4, 5. Galleywood Common. Two old wells.

Information from Mr. ROLFE, the sinker, to W. H. DALTON.

4. Near Windmill.

[Bagshot Beds.]	Sand	6	24 ft.
	Sandy loam ...	18	

5. Half-a-mile west of Galleywood Farm.

Gravel 15 ft. [Mapped as London Clay. Probably a pocket.]

Great Bentley.

Ordnance Map 224, new ser. (Essex 38, NW., chiefly).
Geologic Map 48, SW.

According to Dr. THRESH's Report of 1901, p. 125, the supply was then from shallow wells, many of which had to be closed. There was a difficulty in finding water in some parts.

1. Clacton Waterworks. In field in which are the works (p. 77). A little NE. of the church. Trial-bore. 1898.

Communicated by Messrs. TAYLOR and SONS.

89 ft. above Ordnance Datum.

Lined with tubes $24\frac{1}{2}$ ft. into the Chalk. Never used.

	Thickness. Ft.	Depth. Ft.
Gravel	24	24
London Clay	121	145
Woolwich and Reading Beds ...	69	214
[Upper] Chalk	66	280

For an analysis of the water, see p. 397.

2. Clacton Waterworks. Later boring (of 9 in. diameter).

Made and communicated by Messrs. F. SMITH and SON, of Grimsby. 1913.

Rest-level of water 70 ft. down. Yield tested by a pump 250 ft. down. The tests were made when a depth of 350 ft. had been reached, and at 500 ft. The yield on each occasion was only about 250 gallons an hour.

		Thickness. Ft.	Depth. Ft.
Soil	... ...	1	1
[? Glacial Drift, 35 ft.]	Silt	$1\frac{1}{4}$	$2\frac{1}{4}$
	Fine sand	1	$3\frac{1}{4}$
	Rough sand and gravel	$32\frac{3}{4}$	36
[London Clay, 110 ft.]	London Clay	89	125
	Blue silty clay	10	135
	Fine green sand...	3	138
	Blue silty clay	8	146

Great Bentley, cont.

		Thickness. Ft.	Depth Ft.
[Reading Beds, 64 ft.]	Hard red clay	2	148
	Stone	2	150
	Blue silty clay	2	152
	Hard red clay	16	168
	Hard blue clay	2	170
	Stone	1	171
	Hard green clay...	8	179
	Green sand and clay	8	187
	Blue clay	16	203
	Blue silty clay	7	210
[Upper Chalk, 290 ft.]	Flint	1	211
	Chalk, with flint at 275 to 276 ft. ...	167	378
	Chalk and flint boulders	122	500

Great and Little Braxted.

Ordnance Map 241, new ser. (Essex 45, NW., chiefly). Geologic Map 47.

According to Dr. THRESH's Report of 1901, p. 109, a public pump supplied the largest group of houses, and there was also a tank intercepting a spring, rising in a wood half a mile off. Both parishes were fairly well supplied.

There are several small springs in these parishes.

Great Bromley.

Ordnance Map 224, new ser. (Essex 28, NE. and SE.). Geologic Map 48, SW.

Great Bromley Lodge. About 1890.

Communicated by Dr. COOK.

Just above the 100-ft. contour-line.

Said to be 400 ft. deep and 90 ft. into Chalk.

For analysis of the water, see p. 397.

According to Dr. THRESH's Report of 1901, p. 126, except for the above the usual supply was from shallow wells, some not all that could be desired.

Great Burstead = Billericay, which see.

Ordnance Maps 257, 258, new ser. Geologic Map 1, NE.

Dr. THRESH's Report on the Water Supply of Essex, 1901, p. 83.

Population about 1,970. Water-supply got wholly from shallow wells and springs. As many as ten houses used a single well. A general scarcity of water in summer.

The supply now comes from the Southend Co. (1913)

Dr. CARTER, M.O.H. of the Billericay Rural District, says that at Barley Lands (SSE. of Slice's Gate), a well was sunk to the depth of 308 ft. Water rose to 50 ft. from the surface and was lowered 3 or 4 ft. on pumping 300 to 400 gallons.

Great Canfield.

Ordnance Maps 240, 222, new ser. (Essex 32, NE. and SE.). Geologic Map 47.

1. Bullocks Farm.

Boulder Clay and gravel	about 40		175 ft.
London Clay	,, 130		
Mottled sand [Reading Beds] with water	,, 5		

2. Hellman's Cross. West-north-west of the village. 1893.
Made and communicated by Mr. G. INGOLD.
Boulder Clay 11 ft.

3. Mr. F. Martin's Farm.
Communicated by Mr. FEATHERBY.
Two bore-holes, each 25 ft. in Drift.

Great Canfield, cont.

4. The Vicarage. 1889.
Bored and communicated by Mr. G. INGOLD.

		Thickness. Ft.	Depth. Ft.
Soil ...		1	1
[? All Drift.]	White clay ...	15	16
	Blue clay ...	9	25
	Red sandy clay ...	5	30

According to Dr. THRESH's Report of 1901, p. 117, Great and Little Canfield were supplied by two public and several private wells.

Great Chesterford.

Ordnance Map 205, new ser. (Essex 2, NE. and SE.). Geologic Map 47.

1. Park Road. 1890.
Made and communicated by Mr. G. INGOLD.
Shaft 162 ft., the rest bored.
Water-level 156 ft. down at first; but lowered $5\frac{1}{4}$ ft. from April 15th to July 23rd. The well having gone dry since, will have to be deepened. (1891).

Made ground ...	2	192 ft.
Boulder Clay ...	8	
Chalk	182	

2. Park Road, a little northward of the church. 1894.
Boring made and communicated by Messrs. TILLEY.
[Remarks in these brackets added from specimens.]
About 142 ft. above Ordnance Datum.
Level of surface-water, in well, 25 ft. down. Level of Chalk-water, 21·4 ft.

		Thickness. Ft.	Depth. Ft.
Old well (the rest bored) ...		—	30
[Presumably all Glacial Drift.]	Rough ballast [stones of various sorts: chalk, flint, sandy limestone] ...	8	38
	Yellow running sand [brownish-grey, sharp, with chalk grains]	16	54
	Chalk-stones [pebbles of hard chalk] and flints ...	2	56
	Grey running sand [fine pale grey, with chalk grains] ...	12	68
	Chalk-stones [pebbles of hard chalk] and flints [a pebble of red chalk and a rolled piece of a large *Gryphœa*] ...	2	70
	Grey loamy sand [pale grey, fine, calcareous] ...	$63\frac{1}{2}$	$133\frac{1}{2}$
	Flints [clean gravel, mostly flint chips; some foreign stones; some small pebbles of hard chalk] ...	$4\frac{1}{2}$	138
	Brown clayey sand [pale grey, fine, calcareous] ...	3	141
	Yellow clay and chalk [pieces of chalk and fine, buff, calcareous, clayey sand] ...	5	146
	Red loamy sand [fine, light-brown, calcareous, compacted sand; some bits of chalk] ...	4	150
	Red sand [sharper, brown-grey, with chalk grains] ...	6	156
White chalk ...		?	?

This is one of the sections proving the presence of a deep channel filled by Glacial Drift (see p. 64). For an analysis of the water, see p. 397.

Great Chesterfield, cont.

3. The Elms (a house by the cross-roads, at the eastern end of the village). 1893.

Made and communicated by Mr. G. INGOLD.

Chalk. 46½ ft.

According to the Report of the Medical Officer (W. ARMISTEAD) for 1912, there are many private wells. Most in the village are dug in Chalk or in gravel, but some are bored, one at Crown House to 220 ft., one at the brewery to 200 ft., and two others about the same.

There is no public supply, and the private wells mostly vary from 10 to 60 ft. in depth.

Great Clacton, see Clacton-on-Sea.

Outlying farms and houses are supplied by shallow wells and tube-wells.

Great Dunmow.

Ordnance Map 222, new ser. (Essex 23, SE., 24, NW. and SW., 32, NE., 33, NW.). Geologic Map 47.

1. Bigod's Wood, north of the town. Keeper's Lodge, at the northern end. 1896.

Made and communicated by Mr. G. INGOLD.

[Glacial Drift.]	Brown [Boulder] clay	37	56 ft.
	Sand and gravel ...	19	

2. Deadman's Lane. Infectious Hospital. Boring for the Rural District Council. 1903.

215·18 ft. above Ordnance Datum.

Made and communicated by H. G. FEATHERBY.

Water-level 45 ft. down in 1903. (Chalk water.) Analysis, p. 398.

		Thickness. Ft.	Depth. Ft.
Soil ...		1½	1½
[Drift.]	Fine red sand, with water ...	5	6½
	Loamy gravel ...	1½	8
London Clay.	Very tough brown and blue clay ...	56½	64½
	Black loamy sand, with a little water	½	65
	Very tough brown and blue clay (traces of iron-pyrites at base) ...	38	103
	Very hard fine grained grey-stone ...	1	104
	Very tough, brown and blue clay ...	8	112
	Black loamy sand [Basement-bed] ...	8	120
Woolwich and Reading Beds.	Very tough brown clay ...	12	132
	Very tough blue clay ...	16	148
	Green and red mottled sandy loam ...	8	156
	Green clay ...	4	160
	Brown clay ...	10	170
	Dark grey clay ...	13	183
	Green and red mottled sandy loam ...	2½	185½
	Small green-coated flint-pebbles ...	½	186
[Upper] Chalk, soft for 50 ft., then increasingly harder; with flints ...		100	286

Bottom of casing at 250 ft.

Of the beds, from 156 to 185½ ft., it is said: These clays are sandy and become increasingly so lower down. Sand in a very fine state of subdivision.

3. For the supply of Dunmow. 1907. The works were bought from the Company by the Dunmow Rural District Council in 1912.

Made and communicated by P. F. MACKENZIE RICHARDS.

205 ft. above Ordnance Datum.

Great Dunmow, cont.

Lined with 10-in. tubes to 71½ ft. down, and with 6½-in. tubes to 216 ft. down, the rest in open Chalk.

Rest water-level 32 ft. down. Day and night continuous pumping at 5,000 gallons an hour did not affect water-level. A wooden lining inserted between 10 and 14 ft. down collapsed and the bore was restarted 6 ft. to the east.

		Thickness. Ft.	Depth. Ft.
Soil	... ...	1	1
[Drift.]	Clay and stones	2	3
	Dark sand and gravel	1	4
	Iron-coloured clean, sharp sand and gravel. Some water	10	14
[London Clay.]	Soft light-coloured brickearth... ...	2	16
	Dark blue soft-grained clay	20	36
	Firm, tough blue clay	24	60
	Dark slate-coloured firm, soft-grained silty clay	20	80
	Dark slate-coloured very silty clay (soft)	32	112
	Yellowish clay (soft)	1	113
[Woolwich Beds and Thanet Beds.]	Dark grey clay and sand with little water	10	123
	Fine grey sand. Fair supply of water	13	136
	Yellow mottled soft clay	12	148
	Dark red loamy clay, rather silty ...	4	152
	Green silty clay	2	154
	Very fine grey silt and sand. Fair supply	16	170
	Flint. Fair supply	½	170½
[Upper Chalk.]	Very soft chalk. Fair supply ...	57	227½
	Firmer chalk. Fair supply	13	240½
	Firm chalk (over 5,000 gals. per hour	? 59½	300

For an analysis of the water, see p. 398.

According to Dr. THRESH'S Report of 1901, p. 117, there were then three public wells, and two stand-pipes connected to a spring on higher ground. The inhabitants generally were supplied from wells in the gravel on which the town stands, many of them being liable to pollution from soakage of filth.

Now the mains from the above public well, No. 3, go throughout the town and give the supply.

4. Brewery in North Street. Well in the centre of the Brewery-yard.
Communicated by Inspector HAMILTON.
About 200 ft. above Ordnance Datum.
Water-level 30 ft. down (1899). Yield, 500 barrels a day pumped without lowering the water one inch (1899).

	Thickness. Ft.	Depth. Ft.
[Drift] Gravel	10	10
London Clay	180	190
Chalk	200	390
(Green ?) Sand ...	10	400

Presumably the sand should have come above the Chalk; but there must be much more between the London Clay and the Chalk.

For an analysis of the water, see p. 398.

Great Easton.

Ordnance Map 222, new ser. (Essex 23, NE.). Geologic Map 47.

Dr. THRESH, Report on the Water Supply of Essex, 1901, p. 117, in which it is given as Easter.

About 220 houses (population 674) then got water from 2 public and 26 private wells.

Great Hallingbury.

Ordnance Maps 222, 240, new ser. (Essex 31, NE.). Geologic Map 47.

1. Harp's Farm.
Information from Mr. G. INGOLD.

[? All Glacial Drift.]	Brown, blue, and black clay Sand	128 ft.

2. Start Hill. Tile Kiln Cottage.

Brown clay ...	25	60 ft
Black sandy loam ...	35	

3. The Rectory. 1897.
Made and communicated by Mr. G. INGOLD.
Water 66½ ft. down. Strong spring.

		Thickness. Ft.	Depth. Ft.
Made ground ...	... ...	3	3
[Glacial Drift.]	Brown boulder clay	4	7
	White boulder clay	8	15
	Dark clay	5	20
	Blue chalky clay	36	56
	Yellow sand	3	59
	Red sand with veins of gravel	10	69

4. Wallbury Camp.
Information from Mr. G. INGOLD.
[Glacial Drift.] Sand and gravel, 50 ft.

5. Woodside Green. This may be in Little Hallingbury.
Made and communicated by Mr. G. INGOLD.
Water-level 85 ft. down.

[Glacial Drift.]	White and blue Boulder clay	85	88 ft.
	Red sand	3	

According to Dr. THRESH's Report of 1905, p. 51, with the exception of a few cottages, the parish was fairly well supplied from wells from 30 to 80 ft. deep.

The mains of the Herts. and Essex Company now extend into the parish.

Great Henny, see Henny.

Great Holland.

Ordnance Map 224, new ser. (Essex 39, SE.). Geologic Map 48, SE.

The supply was wholly from shallow wells and the houses on the Common needed a better supply (Dr. THRESH's Report of 1901, p. 126). Now in the area of the Tendring Hundred Co.

Great Horkesley.

Ordnance Map 223, new ser. (Essex 18, SE.). Geologic Map 48 NW.

Dr. J. W. COOK reports that shallow wells are the usual source of supply.

Great Leighs.

Ordnance Map 241, new ser. (Essex 34, SW.). Geologic Map 47.

Dr. THRESH, Report on the Water Supply of Essex, 1901, p. 102.

The houses were very scattered, supplied by springs and shallow wells. In 1895 a roadside-spring was impounded. Here and there cottages were dependent on ponds. Chatley Hamlet was supplied from several private wells, the principal pump being at the Dog and Partridge Inn.

His Report for 1905, p. 46, adds that the supply was not sufficient, and that attempts to get water for cottages on the Braintree Road had failed.

Little Leighs is similarly supplied (p. 47), and each place has a public well. Where the Boulder Clay is thickest the wells are some 60 ft. deep.

Great Maplestead.

Ordnance Map 223, new ser. (Essex 11, SE., 12, SW., 16, NE., 17, NW.)
Geologic Map 47.

According to Dr. THRESH's Report of 1901, p. 120, there were then two public pumps, one fed from a spring. Another public supply was from a brook.

In the Report of 1905 he says that the two public pumps supplied half the population. Many houses were supplied from a spring and the rest from shallow wells averaging 28 ft. deep.

Great Oakley.

Ordnance Map 224, new ser. (Essex 29, NE., 30, NW.). Geologic Map 48, SE.
Pewit Island. Marshland. 1869.
From information on the spot.
Bored throughout.
Water to the surface of the ground (below the level of high-water). Supply abundant. Abandoned.

To Chalk ...	110	185 ft.
In Chalk ...	75	

According to a note from Mr. H. MILLER of Ipswich, beds of cement-stone were met with at depths of 20 and 80 ft.; and the depth to the Chalk was only 100½ ft.

According to Dr. THRESH's Report of 1901, p. 127, in Great and Little Oakley the only supply then was from shallow wells, two lined with concrete-tubes.

The mains of the Tendring Hundred Water Co. now pass through both parishes.

Great Parndon.

Ordnance Map 240, new ser. (Essex 40, SE., 41, SW.). Geologic Map 1, NW.

1. Brockles Farm. About a mile south-south-east from the church.
From Mr. INGOLD.
Hard London Clay, very little water, to 100 ft.

2. Hare Street Green. (? Public well.)
Sunk and communicated by Mr. G. INGOLD.
Shaft throughout. Water in the sand.

[Drift.]	Gravel and sand ...	18	29½ ft.
	White loam	3½	
	Sand	½	
	Loam	2	
	Loose chalky sand ...	5½	

3. Kingsmoor. (Kingsmoor House), about three-quarters of a mile south-south-east from the church.
Made and communicated by Messrs. A. WILLIAMS and Co.
Shaft 6 ft., the rest bored.
Water-level 50 ft. down. Cield 300 gallons an hour.

		Thickness. Ft.	Depth. Ft.
[? Glacial Drift.]	Clay	6	6
	Clay and stones ...	8	14
	Brown clay and sand ...	16	30
	White sand and clay ...	20	50
	Gravel	16	66

Great Saling.

Ordnance Map 222, new ser. (Essex 24, NE., SE.). Geologic Map 47.

1. Communicated by J. BROWN, of Braintree.
Shaft 160 ft., the rest bored. 20 ft. of water in the shaft.

Great Saling, cont.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift, 75 ft.]	"Chalky Gault" [Boulder Clay]	12	12
	Dry sand and gravel	28	40
	Wet sand	35	75
London Clay ...	... ...	165	240
Reading Beds.	Plastic clay and green sand ...	30	270
	Dark clay and green sand ...	30	300
[Upper] Chalk...	... ...	110	410

2. Saling Grove. About 300 yds. north of the house.
291 ft. above Ordnance Datum.
Water-level 180 ft. down (1912). Has fallen about 21 ft. in the last 30 years (1912).
Chalk about on Ordnance Datum (about 290 ft. down).
Well over 385 ft. deep. Lined with brickwork and tubes.
For analysis of the water, see p. 398.

Great or Old Sampford.

Ordnance Map 222 (Essex 10, SW.). Geologic Map 47.

1. Mr. Stubbing's Cottages. 1877.
241 ft. above Ordnance Datum.
Made and communicated by Mr. G. Ingold.
Shaft 35 ft., the rest bored. Water-level 20 ft. down.
Blue [Boulder] Clay, with sand at bottom, 59 ft.

2. Tindon End.
Water within 40 ft. of surface.
Boulder clay to 'Rock' said to be 140 ft.

No public supply. Water got from shallow wells and ? springs.

Great Stambridge.

Ordnance Map 258, new ser. (Essex 70, SE.). Geologic Map 1, SE.
Mill. Old well.
Information from Mr. Purkis to W. H. Dalton.

Gravel ...	14	310 ft.
London Clay ...	256	
Sand	40	

According to Dr. Thresh's Report of 1901, p. 79, the public shallow well formed the chief source of supply, outlying houses having shallow wells. On the whole the quality of the water good.

Great Tey.

Ordnance Map 223, new ser. (Essex 26, NE. and SE.).
Geologic Maps 47, 48, SW.

Dr. J. W. Cook's Report for 1900. Repeated in Dr. Thresh's Report of 1901, p. 136.

In the village there were two public wells, lined with large glazed tubes, and two private wells similarly lined. Other supplies were from shallow wells.

Great Totham.

Ordnance Map 241, new ser. (Essex 45). Geologic Map 47 and 1, NE.

According to Dr. Thresh's Report of 1901, p. 110, water was then chiefly got from a public pump. There were several private wells. Some people got water from a brook, undoubtedly polluted.

Since then a second public pump has been provided. The water comes from gravel.

See also **Osea** (a detached part of the parish).

Great Wakering.

Ordnance Map 258, new ser. (Essex 79, NW.). Geologic Map 2.

1. Great Wakering Pumping Station, or No. 16 of the Southend Water Co. Communicated by E. C. Bilham, Engineer to the Company.

		Thickness. Ft.	Depth. Ft.
Soil and made ground		2½	2½
[River Drift.]	Brickearth	6	8½
	Sand and shingle	7¾	16¼
[London Clay, 422¼ ft.]	Yellow clay	1¼	17½
	London Clay	421	438½
[? Oldhaven Beds, 13 ft.]	Sand and shells	1¼	439¾
	Hard sand	3¼	443
	Sandy clay	7	450
	Pebbles and shells	1½	451½
[Woolwich Beds, 38½ ft.]	Sand	3½	455
	Hard sand	1	456
	Hard green sand	6	462
	Shells and sand	1	463
	Green sandy clay	19	482
	Hard brown clay and pebbles	8	490
[Thanet Beds, 104½ ft.]	Sand	1	491
	Soft sandy clay	54	545
	Stiff blue clay	14	559
	Brown sandy clay	34½	593½
	Flints	1	594½
[Upper] Chalk		24	618½

2. Rushley, an island north-eastward of the village. 1829. — Bannester, in *The History and Topography of the County of Essex*, by T. Wright, 4to, vol. ii, p. 634.

A boring. Water overflowed.

	Thickness. Ft.	Depth. Ft.
Stiff blue very hard dry clay [Alluvium]	22	22
Quicksand (consisting of gravel, sand, cockle, oyster and mussel shells) with much salt water	about 16	38
Stiff blue clay, with layers of oyster-shell and sometimes chalk. At a depth of 400 ft. from the surface, dark and more powdery earth. At 420 ft. from the surface, a small quantity of sand mixed with the clay, increasing in quantity lower down, until at 450 ft. the earth became very soft	417	455
Hard rock	about ¾	455¾
Below which the rods dropped down	30	485¾

Information from Mr. Purkis makes a well here 345 ft. to the base of the London Clay, and then 40 ft. in sand, to water. But the figures are doubtful.

3. Wakering Wick Pumping Station (or No. 25) of the Southend Water Co. Nearly ½ mile east of Great Wakering Church. Communicated by E. C. Bilham. 17½ ft. above Ordnance Datum. Sunk 427 ft., the rest an unlined boring. Water-level 136¾ ft. down (1912). Lowest (pumping) 309.

		Thickness. Ft.	Depth. Ft.
Soil		1	1
[River Drift.]	Brickearth	5½	6½
	Sharp sand	2	8½
	Sandy loam	6½	15
	Sand and gravel	2	17

Great Wakering, cont.

		Thickness. Ft.	Depth, Ft.
London Clay, lowest 9 feet very hard ...		417½	434½
[? Oldhaven Beds.]	Hard sand and shells ...	3	437½
	Softer sand and shells ...	2	439½
	Sand and shells	2	441½
	Sand, sharper	4	445½
	Sand and pebbles ...	1	446½

4. Messrs. Rutters' Brickfields, near Landwick. May, 1898. Close to the Wakering Wick Pumping Station of the Southend Water Co.

Made and communicated by R. D. Batchelor.

Water-level, 146 ft. down. Yield about 750 gallons an hour.

Sunk well 150 ft., diameter 6 ft. The rest bored.

		Thickness. Ft.	In.	Depth. Ft.	In.
[Drift ?]	Brickearth, &c.	9	0	9	0
	Sand	7	6	16	6
	Clay and sand	1	6	18	0
[London Clay.]	London Clay	361	0	379	0
	Brown clay	3	0	382	0
	Dark clay	56	0	438	0
[?Oldhaven Beds and Reading Beds]	Dead sand	2	0	440	0
	Sand and clay	30	0	470	0
	Peat and clay	15	0	485	0
	Dead green sand	30	0	515	0
[Thanet Beds.]	Sand and clay	5	0	520	0
	Clay	68	0	588	0
	Clay and chalk	11	0	599	0
[Upper] Chalk and flints	... ...	205	2	804	2

For an analysis of the water, see p. 399.

Another note makes this boring 953 ft. deep, in 1902.

According to Dr. Thresh's Report of 1901, p. 80. There were no public wells. The parish depended on shallow wells, giving sufficient water, but of doubtful quality.

Now supplied by the Southend Co. (1913). See analysis, p. 399.

Great Waltham.

Ordnance Maps 241, 240, 222, new ser. (Essex 43, NE.). Geologic Map 47.

At Mr. Tufnell's new cottages (1900), where the main road to Great Waltham branches off from Little Waltham, there is a well about 30 ft. deep.

The water at first is said to have caused diarrhœa. It smelt of sulphuretted hydrogen, the smell vanishing on exposure to air. The water smelt for three years and then the smell suddenly disappeared (the well had been left open) and the well was finished and covered in. Does not smell now (1910), and is wholesome.

For an anlysis of the water, see p. 399.

There are other similar wells between this place and Radley Green.

At Rolphy Green a few cottages were supplied from a pond, well-sinking having failed (1905).

At North End a public well was sunk in 1893.

Great Warley.

Ordnance Map 257, new ser. (Essex 67, SE.). Geologic Map 1, NW. and SW. and (part) London District, Sheet 2.

1. Parsonage.

From Dr. J. Mitchell's MSS., vol. iii, p. 75.

Dug 100 ft.; bored 280 ft. [= 380 only].

The sand below the blue [London] Clay reached at 390 ft.

Great Warley, cont.

2. Warley Common. About half-a-mile south-south-east of Brentwood Railway Station. Ilford Limited. 1903.

Communicated by A. Kennard.

340 ft. above Ordnance Datum.

350 ft. down to water.

Casing pipe, of 8-in. diameter to 672 ft. down. Delivery-pipe, of $3\frac{1}{2}$-in. diameter, to 902 ft. Air-pipe, of 1-in. diameter, to 894 ft. An exceptional air-lift.

		Thickness. Ft.	Depth. Ft.
Bagshot Sand and clays		45	45
London Clay		493	538
[? Woolwich Beds, 47 ft.]	Sandstone	$1\frac{1}{2}$	$539\frac{1}{2}$
	Blue shale and shell-bed	29	$568\frac{1}{2}$
	Rock	$\frac{1}{2}$	569
	Green sand	15	584
	Gravel [pebbles]	1	585
[? Thanet Beds, $81\frac{1}{2}$ ft.]	Shale	4	589
	Rock	5	594
	Soft sand rock	16	610
	Sand rock	20	630
	Sandy clay	35	665
	Flints	$1\frac{1}{2}$	$666\frac{1}{2}$
[Upper] Chalk		$335\frac{1}{2}$	1,002

The divisions are doubtful. The sandstone next below the London Clay may be the basement-bed of that formation, or perhaps this may reach down to 569 ft. The 16 ft. of sand, with pebbles below, may then be Oldhaven Beds and the top two beds (or more), classed as Thanet Beds, may be Reading Beds. For an analysis of the water, see p. 399.

Dr. Thresh, in his Report on the Water Supply of Essex, 1901, p. 68, says that about 45 cottages used shallow wells, ponds forming the main supply in the more outlying parts of the parish. According to J. C. Shenstone (*Essex Naturalist*, 1902, vol. xvii, p. 51), "in old times the villagers of Great Warley drew their water" from old Watergate pond. The supply is now chiefly taken from the South Essex Co.

Great and Little Wigborough.

Ordnance Maps 241, 242, new ser. (Essex 36, SE., 46, NW., NE.). Geologic Map 48, SW.

Dr. J. W. Cook's Report for 1900. Repeated in Dr. Thresh's Report of 1901, p. 136.

These parishes were almost without a water-supply. Nothing but ponds and ditches. Farmers generally carted water from St. Peter's Well, West Mersea.

Great Yeldham.

Ordnance Maps 206, 223, new ser. (Essex 11, NW. and NE.). Geologic Map 47.

According to Dr. Thresh's Report of 1905, p. 64, a public pump supplied about 5 per cent. of the inhabitants, 5 per cent. used springs, 2 per cent. depended on brooks and ditches, but the great majority had private wells from 15 to 20 ft. deep.

Hadleigh.

Ordnance Map 258, new ser. (Essex 77, NE.). Geologic Map 1, SE.

1. Salvation Army Colony. No. 1 Well, 200 yds. south-west of Hadleigh Church.

Communicated by D. C. Lamb.

About 200 ft. above Ordnance Datum.

Well 300 ft., the rest bored.

Hadleigh, cont.

		Thickness. Ft.	Depth. Ft.
[Drift] Gravel	... ...	4	4
London Clay	... ...	491	495
[Lower London Tertiaries.]	Live sand ...	5	500
	Sand and pebbles	11	511
	Dead green sand	61	572
	Blue clay ...	15	587
	Clay and sand ...	6	593
	Dead green sand	21	614
	Blue clay ...	30	644
[Upper] Chalk and flints	... ...	296	940

For an analysis of the water, see p. 400.

2. Salvation Army Colony. No 2 Well. 150 yds. east of Park Farm. Just below 200 ft. above Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Clay	27	27
	Loam	3	30
	Clay	9	39
	London Clay ...	365	404
[Lower London Tertiaries.]	Sand and gravel	16	420
	Dead sand ...	139	559
[Upper Chalk.]	Chalk	203	762
	Flints	½	762½
	Chalk	74½	837

According to Dr. THRESH's Report of 1901, p. 79, the sole supply was from surface-wells; the quantity of water was abundant, but the quality questionable.

The town is now supplied by the Southend Co. (1913).

Hadstock.

Ordnance Map 205, new ser. (Essex 3, NW. and NE.). Geologic Map 47.
New House farm, eastward of the village, on the southern side of the road to Barstow.
? About 190 ft. above Ordnance Datum.
Information from A. E. PITSTOW, Sanitary Inspector, Saffron Walden Rural District Council.
Well dug 60 ft., and then a boring 40 ft. deeper.
Chalk to within 2 ft. of the surface.
There is an average of about 5 ft. of water in the dug well. The suction of the pump (worked by a windmill) is in the boring.
For an analysis of the water, see p. 400.

The village is partly supplied from a well in the churchyard, which must go through a little Boulder Clay to gravel.

Hainault Forest.

Ordnance Map 257 (Essex 66, NW. and SW.). Geologic Maps 1, NW. and SW., and London District, Sheet 2.
Sunk and communicated by Mr. G. EASTELL.

		Thickness. Ft.	Depth. Ft.
[River] Gravel	... ...	16	16
Blue and [variously] coloured [? London] clay	... ...	19	35
[Woolwich and Thanet Beds.]	Brown sand	7	42
	Dark sand with water	28	70
	Grey sand with abundance of water ...	36	106
	Loamy sand. No water	4	110
[Upper Chalk.]	Chalk. No water	40	150
	Chalk with flints and water	15	165

This account was first published in 1872. It is of interest as showing the base of the London Clay at a less depth than one would expect. The site therefore is presumably at a low level (? exact locality).

Hallingbury, see **Great** and **Little Hallingbury.**

Halstead.

Ordnance Map 223, new ser. (Essex 16, SE., 17, SW.). Geologic Map 47.

1. (? At the railway-station.) 1878.

Made and communicated by Messrs. TILLEY.

Shaft and cylinders (from 20 ft. down), 68½ ft., the rest bored.

Water-level 57 ft. 10 in. down.

	Thickness. Ft.	Depth. Ft.
Brown clay and stones	15	15
Blue clay	13	28
Dark sand and water	2½	30½
Yellow loam and little water	6	36½
Light loamy dry sand	9	45½
Coarse gravel and sharp sand	2½	48
Yellow dry sand	10	58
Yellow sand and water	10½	68½

2. Ashfield Lodge.

Information from J. HATLEY.

Boulder Clay	20	140 ft.
Sand, the upper 40 ft. dry, the rest wet	70	
London Clay, to sand	70	

3. The White Hart.

PRESTWICH, *Quart. Journ. Geol. Soc.*, 1859, vol. x, p. 154.

		Thickness. Ft.	Depth. Ft.
Sand and gravel		7	7
[London Clay, 97 ft.]	Yellowish clay	8	15
	Clay	89	104
Reading Beds, 41 ft.	Yellow sand, passing into brown clay	7	111
	Plastic clay	19	130
	Greenish sand	15	145
Thanet Sand	Several layers of sand, passing from a light colour to nearly black...	about 25	170
[Upper] Chalk ...		30	200

4. Waterworks, at north-eastern end of the town. 1862.

From a drawing in the office of the Urban Council, and from Messrs. T. TILLEY & Co.

215 ft. above high-water mark (Essex Coast).

Shaft 140 ft., the rest bored.

Water rose to 90 ft. below the surface, supply abundant.

			Thickness. Ft.	Depth. Ft.
Soil or Made Ground			over 5	5+
Marl [? Boulder Clay], with gravel at bottom, on one side only (2 ft.) ...			nearly 40	45
[London Clay, 83 ft ?]	Blue clay		over 65	110+
	[? basement-bed]	Rock	nearly 10	120
		Brown sand	over 5	125+
		Blue clay ...	3	128+
[Reading Beds, 65 ft. ?]	Sand		2	130+
	Dark sand with clay		nearly 20	150
	Plastic clay		15	165
	Green sand		over 23	188+
	Dark black sand		nearly 2	190
	Pebbles ...		2	192
[Thanet Sand, 38 ft ?]	Dark sand and clay		over 33	225+
	Light-coloured clay		nearly 5	230
[Upper] Chalk ...			100	330

Halstead, cont.

The division between the London Clay and the Reading Beds is hard to make out and may be lower.

This well is now used only in emergencies. For analyses, see p. 401.

Dr. R. B. Low, in a Report to Local Government Board, No. 44, 1889, gives a slightly different version of the section, and says that the pumps bring up 5,000 gallons an hour. The "second boring recently made at a lower level near Parson's Bridge 220 feet deep" must refer to the following. The figures given in Dr. Bulstrode's Report to the Local Government Board (1908) also differ slightly.

5. New Waterworks. At the lower end of the town, close to the River Colne. 1890.

Trial-boring and well and boring within 20 ft. of each other and giving identical sections. P. Griffith, *Trans. Brit. Assoc. Waterworks Eng.*, 1896, vol. i, pp. 118–139.

Trial-boring 12 in. in diameter. Lined with tubes to 160 ft. down.

Abundant supply found at 220 ft., the water rising to within 6 ft. of the surface. Seven days' pumping caused little reduction, and the recovery on cessation of pumping was immediate.

The well was made soon after the trial-boring.

Iron cylinders of 8 ft. 6 in. diameter were forced down to the first bed of clay (about 50 ft.). This bed was utterly useless as a natural bottom and the cylinders were forced down to the second bed of clay (about 62 ft.). This again was useless; indeed, the clay was removed in pumping in such quantities that the boiler-house subsided. Eventually 15 ft. of concrete was used (from about 47 to 62 ft.) to exclude surface-water, but this had to be reinforced by an iron plate.

There is a boring of 12-in. to about 100 ft. and of 8-in. to 250 ft., lined with tubes to about 147 ft. down.

		Thickness. Ft.	In.	Depth. Ft.	In.
[Drift, 40½ ft.]	Gravel	39	0	39	0
	Pebbles	1	6	40	6
[London Clay, 26 ft.]	Sand and loam ...	9	0	49	6
	Loamy clay ...	11	0	60	6
	Clay	5	0	65	6
	Pebbles	1	2	66	8
[Lower London Tertiaries, 75⅓ ft.]	Plastic clay ...	21	4	98	0
	Green sand ...	13	0	111	0
	Light grey sand	10	0	121	0
	Dark grey sand	14	0	135	0
	Dark green sand	5	0	140	0
	Pebbles	2	0	142	0
[Upper Chalk, 142 ft.]	Soft chalk ...	46	0	188	0
	Hard chalk ...	62	0	250	0
Deepened later to ...	...	...	...	300	0

It was intended to connect the trial-boring to the pumping well by an adit in the clay, but as the clay was thin and not watertight and the beds above were saturated with surface-water, this was unpracticable, and the well was continued as a boring instead.

The great difficulties met with in excluding the surface-water in the upper beds from the pumping-well are commented on. The pumping-well (previous to its continuation as a boring) could not be pumped dry until special measures had been taken to form an artificial bottom.

Pumping capacity, about 160,000 gallons a day of ten hours.

This well was deepened 50 ft. in 1912, and the supply largely increased. The water-level, which had fallen, rose to 14½ ft. down.

Works established, 1862; additions, 1889-1891; population supplied, 7,000; area of supply, the Urban District; yearly supply, 51,100,000 gallons; daily consumption per head, for all purposes, 20 gallons.—*Water Works Directory*, 1911, p. 158.

Halstead, cont.

6. Greenstead Hall (? Halstead Lodge of old map). South-south-east of town. 1906.

Made and communicated by Messrs. ISLER.

Lined with 260 ft. of 5-in. tubes from 2 ft. down.

Water-level 122 ft. down. Supply 1,200 gallons an hour.

		Thickness. Ft.	Depth. Ft.
Soil	...	$\frac{1}{4}$	$\frac{1}{4}$
[Glacial Drift.]	Large ballast [coarse gravel] ...	1	$1\frac{1}{4}$
	Light-coloured sandy clay and ballast	$9\frac{3}{4}$	11
	Sandstone [? boulder] ...	$\frac{1}{2}$	$11\frac{1}{2}$
	Black flints ...	$3\frac{1}{2}$	15
	Light-coloured clay sand and mixed chalk ...	6	21
	Dark clay sand and mixed chalk ...	$6\frac{1}{2}$	$27\frac{1}{2}$
	Sand and pebble ...	$1\frac{1}{2}$	29
	Grey sand ...	3	32
	Grey sand and pebbles ...	3	35
	Red sand ...	4	39
	Dead yellow sand ...	$3\frac{1}{2}$	$42\frac{1}{2}$
	Grey blowing sand ...	$7\frac{1}{2}$	50
[London Clay.]	Hard blue clay ...	7	57
	Hard brown clay ...	67	124
	Hard blue clay ...	26	150
	Clay-stone ...	$2\frac{1}{2}$	$152\frac{1}{2}$
	Hard brown clay and stone ...	$5\frac{1}{2}$	158
	Dark sandy clay ...	20	178
	Black pebbles [Basement-bed] ...	3	181
[Reading Beds.]	Light-brown mottled clay ...	3	184
	Loamy sand ...	6	190
	Dark brown mottled clay ...	2	192
	Light-brown clay ...	15	207
	Coloured sand ...	5	212
[? Thanet Sand.]	Fine brown sand ...	6	218
	Fine grey sand ...	22	240
	Fine brown sand ...	8	248
	Dark green sand ...	6	254
	Black flints ...	2	256
[Upper Chalk.]	Chalk ...	21	277
	Chalk and flints ...	123	400

Another well at Greenstead Hall. 1906. Also from Messrs. ISLER, gave a like section, but only went to 97 ft. down.

A third well, taken to $50\frac{1}{2}$ ft., was also identical.

This last well or boring is lined with 50 ft. of 6-in. tubes from 2 ft. down, the bottom 3 ft. being perforated. Water-level $41\frac{1}{2}$ ft. down. Water easily exhausted, and the sand blowing in.

Part of the parish is not in the Urban District. Halstead Rural is supplied from a public well, 40 ft. deep (with pump), yielding good water, and by two shallow draw wells, supplied from springs. Supply abundant and good. (Dr. THRESH's Report of 1901, p. 121.) There were many private wells, a few people depended on rain-water, and a few were supplied from the mains of the Urban District Council. (Report of 1905, p. 66.)

Ham, see **East** and **West Ham.**

Hanningfield, see **East, South,** and **West Hanningfield.**

Harlow.

Ordnance Map 240, new ser. (Essex 41). Geologic Map 47 and 1, NW.

1. Kingsmoor House (Mr. J. Todhunter).

Made and communicated by Messrs. A. WILLIAMS and Co.

Water-level 50 ft. down.

Harlow, cont.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Clay and stone	10	10
	Clay and sand	16	26
	White sand and clay ...	24	50
	Gravel	16	66

2. Potter Street (Whitehouse). At the northern part of the hamlet, nearly 2 miles south of Harlow.

Communicated by Mr. FORDYCE, Steward of Farndon Hall.

Heavy clay-loam, with a small bed of sand every 8 or 10 ft.	154	178 ft.
Blackish loam, with sand and rough gravel ...	4	
Bored through heavy clay, without increase of water	20	

3, 4. Two wells. Made and communicated by Mr. INGOLD.

3. French's Farm. 1870.
Shaft 34 ft., the rest bored.
London Clay ... 120 ft.

4. Mr. Arkwright's Cottages. 1872.
Shaft 33 ft., the rest bored.
London Clay ... 83 ft.

In 3 water from vein of sand at 110 ft. In 4 no water.

Harwich.

Ordnance Map 224, new ser. (Essex 21, SE.). Geologic Map 48, NE.

In 1783 Sir T. H. PAGE read a paper to the Royal Society which contains some interesting references on old conditions of water-supply, as follows:—

"The inhabitants of the town of Harwich had chiefly depended on rains for their supply, the wells being in general brackish from the filtration of salt-water. The neighbourhood, to many miles distance, was not better furnished."

He says of the "King's Wells at Harwich" that "They were begun the 6th of May, 1781, . . and finished the 29th of September following."

"The wells in this neighbourhood . . . being very shallow, and only depending on springs from the upper surfaces of the ground, have but little water in the summer, and the quality of it is very bad. . . It was imagined . . . that the most likely way to obtain a better spring was to sink a well from higher ground, and to endeavour to penetrate through a rock which lay a few yards under the level of the country . upon the chance of cutting a spring of better water, that might be unconnected with the land-drains. The experiment answered in every respect, as there was not a drop of water found till the rock had been entirely cut through, when, upon finding a considerable quantity of moist sand, and boring into it, a plentiful spring was discovered, and has supplied the troops ever since with very good water. It is probable this supply, the spring being very powerful, will be found equal to every demand for public and private purposes, in the dryest seasons. After this success, as matter of curiosity, an old well was made deeper, by excavating through the rocks, where a good spring was also found; but as that well had been originally sunk from low ground, a great deal of the bad water from the upper drains, &c., mixes with it, and gives it a disagreeable taste."[1]

It is clear from the above that water was originally got here at the base of the London Clay.

[1] *Phil. Trans.*, 1784, vol. lxxiv, pages quoted, 9, 18, 19.

Harwich, cont.

1. 'First Section in the town of Harwich.'

Prof. Sedgwick. *Ann. Phil.*, ser. 2, vol. iii, p. 352 (1822).

		Thickness. Ft.	In.	Depth. Ft.	In.
[Recent and Tertiary, 80 ft.]	Soil	3	0	3	0
	Sand, a strong spring of salt water ...	17	0	20	0
	Blue clay	20	0	40	0
	Shingle and gravel	20	0	60	0
	Red coarse sand	7	0	67	0
	Coarse gravel	4	0	71	0
	Coarse dark sand	6	0	77	0
	Green and red clay	1	2	78	2
	Green clay	1	10	80	0
[Upper Chalk, 276 ft.]	Chalk	28	0	108	0
	Chalk mixed with fine sand	0	9	108	9
	Chalk, grey from the mixture of dark sand; several flints and pieces of septaria	72	0	180	9
	Pure carbonate of lime...	176	0	356	9

Work then abandoned.

2. Second Section, commencing 198 ft. south of the preceding, and 8 ft. above the High-water Mark.'

Same authority.

	Ft.
Soil	4
Sand containing salt springs	12
Blue clay containing selenite, &c.	74
Gravel with vegetable matter ...	Unknown

3. West Street. [Before 1826.]

Rev. W. B. Clarke, *Trans. Geol. Soc.*, ser. 2, vol. v, p. 370, reprinted (with some errors) in W. H. Lindsey's 'Season at Harwich,' pt. 2, p. 145.

		Thickness. Ft.	Depth. Ft.
Diluvium-earth		3	3
Sand (salt spring)		12	15
London Clay, "Platamore"		9	24
[Reading Beds, 40 ft.]	Shingle and gravel	12	36
	Red sand	9	45
	Coarse gravel	6	51
	Coarse dark sand	9	60
	Green and red clay, mixed ...	1½	61½
	Green clay	2½	64
[Upper Chalk, 293 ft.]	Chalk, with pyrites and *echini*	30	94
	Chalk and a peculiar white sand	10	104
	Chalk, with shells	72	176
	Chalk marl [marly chalk] ...	60	236
	Boring continued	121	357

4. A newer boring, begun in 1826, left off in 1827, 70 yds. north of the above (same authority).

		Ft.	Ft.
*London Clay, greyish, marly		70	70
[Reading Beds]	Compact clay (mottled red and lilac)	10	80
	Fine sand, with salt water	8	88
Chalk		192	280

* [Part of this must belong to the Reading Beds.]

Harwich, cont.

5. By the Harbour, just west of the Great Eastern Hotel. 1854–7.

PRESTWICH, *Quart. Journ. Geol. Soc.*, vol. xiv, p. 249; and BRUFF, *Proc. Inst. Civ. Eng.*, vol. xix, p. 21.

6 ft. above high-water mark.

Shallow shaft, the rest bored.

		Thickness. Ft.	Depth. Ft.
Earth [made ground, mud ?]		10	10
Red gravel		15	25
London Clay. Platimore, mixed with chalk and white sand [? Blackheath Beds in part]		23	48
[Blackheath Beds.] Coarse dark gravel		10	58
[Reading Beds, 20 ft.]	Plastic clay	7	65
	Bluish plastic clay, with green sand (1)	1½	66½
	Red plastic clay, with green sand (1)	3½	70
	Greenish sand (1)	2	72
	Greenish and red sand (1)	3	75
	Dark red (or blue) clay	3	78
[Upper, Middle and Lower Chalk, 890 ft.]	Chalk, with flints in layers 5 or 6 ft. apart, and with shells	690	768
	Chalk without flints (2)	162	930
	Chalk Marl with thin layers of rocky chalk	38	968
Gault mixed with green sand		22	990
Gault		39	1029
Hard dark bluish-grey slaty rock (3) [some of the specimens of this seem to show planes of bedding, cleavage, and jointing]		69	1098

The beds marked (1) are thus massed in PRESTWICH's account:

Bluish clay with green sand ... 3½ ft.
Green and red sand intermixed ... 5 ft.

The bed marked (2) is given as 160 ft.
,, (3) ,, 44½ ft.

Making the depth to the chalk 76½ ft., and the depth to the hard rock 1,025½ ft.

A specimen of the bottom rock, from 1,050 feet, is described by A. J. JUKES-BROWNE as dark purplish-grey compact fine-grained hard argillite and a specimen from 1,070 feet as similar. From the microscopic examination of a slide from the former, Prof. T. G. BONNEY concludes that the principal constituents are mica, decomposition products of felspar, some iron-oxides and a little quartz. Formerly thought to be of Lower Carboniferous age, this rock is now taken to be older, like the old rocks of Stutton and Weeley. Prof. MALAISE is inclined to class them as Lower Devonian; some other geologists as still older.

6. Public Supply.

In 1865 Dr. MILROY said, "The water-supply of Harwich is derived entirely from rainwater stored in tanks, and from surface wells. The water from these wells is so brackish that it is not used for drinking or cooking, but only for washing and cleansing. The tank water, gathered from the roofs of the houses, both looks and tastes smoky, if not filtered. A dense smutty deposit forms at the bottom of the tanks."

"Many of the poorer inhabitants are very badly off for drinkable water; they have to buy every drop of their daily supply." *

This state of things has, of course, passed away, and the supply is now got from the Tendring Hundred Waterworks Co.

* 8 Rep. Med. Off. Privy Council, 1866, p. 247.

Hatfield Broad Oak.

Ordnance Map 240, new ser. (Essex 31, SE., 32, NW. and S.W.).
Geologic Map 47.

1. Cage End. Boring. 1892.
Made and communicated by Mr. G. Ingold.

[Glacial Drift.]	Brown Boulder Clay ...	14	27 ft.
	Blue Boulder Clay ...	13	

2. The Grange. Over $1\frac{1}{2}$ miles south of the church; but there is another 'The Grange' on the map, about the same distance north-eastward of the church. Hatfield Regis Grange?

Sunk and communicated by Mr. G. Ingold.

[Glacial Drift.]	White and blue Boulder Clay	70	74 ft.
	Gravel	4	

3. Near the Grange. A mile east of north of Barrington Hall. 1893.
Made and communicated by Mr. G. Ingold.

[Glacial Drift.]	Light-brown Boulder Clay	8	20 ft.
	Dark-brown Boulder Clay	7	
	Loose chalky rubble ...	5	

4. South end of the Green. 1869. $3\frac{1}{2}$ ft. of water.
From observation. W. H. Penning.

Glacial Drift.	Dark grey Boulder Clay	65	68 ft.
	Sharp light coloured sand, with small pebbles of quartz and flint	3	

5. Another at south end of Green. 1892.
Made and communicated by Mr. G. Ingold.

[Boulder Clay.]	Brown clay ...	14	27 ft.
	Blue clay ...	13	

6. Half a mile south-east of the church. 1889.
Made and communicated by Mr. G. Ingold.
Shaft 66 ft., the rest bored.

		Thickness. Ft.	Depth. Ft.
[Boulder Clay.]	Brown clay	15	15
	Blue and brown clay ...	5	20
	Blue clay	61	81

7. Taverner's Green. About $1\frac{1}{4}$ miles north-east of the church. 1896.
Made and communicated by Mr. G. Ingold.

Light-brown Boulder Clay ...	16	20 ft.
Loose rubbly Chalk, with water	4	

8. Hatfield Heath. The Brewery.
10 ft. of water.

Two accounts, by the foreman at the brewery, and by Mr. Watson, of Bishop's Stortford, vary considerably, thus:—

Gravel and sand ...	6 or 7 feet in one,	20 feet in the other.
Clay	120 ,, ,, ,,	80 ,, ,, ,, ,,
Gravel or sand,	? touched.	
Total depth	130 ,, ,, ,,	100 ,, ,, ,, ,,

9. Hatfield Heath. Mr. Bowyer's. 1885.
Made and communicated by Mr. Ingold.
Water from sand and gravel. 200 gallons in 24 hours.

[Glacial Drift.]	Loamy gravel ...	7	20 ft.
	Loamy sand ...	1	
	Gravel	2	
	White clay ...	10	

Hatfield Broad Oak, cont.

10. Hatfield Heath. (? Public well.) 1893.

Made and communicated by Mr. G. INGOLD.

[Boulder Clay.]	Brown clay ...	21	23 ft.
	Blue clay ...	2	

11. Wolard's Oak (? Woolards Ash), $1\frac{1}{2}$ miles east-north-east of church.

Communicated by Mr. FEATHERBY.

275 ft. above Ordnance Datum.

Boulder Clay 50 ft.; no water.

According to Dr. THRESH's Report of 1901, p. 118, there was a public supply from a spring feeding three stand-pipes. Also two public wells and many private ones.

The parish is now supplied with water by the Hatfield Broad Oak Water Co., which takes water from the mains of the Herts and Essex Co. (1913).

Hatfield Peverel.

Ordnance Map 241, new ser. (Essex 44, NE. and SE.). Geologic Map 47.

1. Hatfield Place. 1900.

Made and communicated by Messrs. C. ISLER and Co.

About 147 ft. above Ordnance Datum (according to Ordnance Map, about 110).

285 ft. of tubes of 4 in. diameter, from the surface down to 285 ft.

Water-level 45 ft. down (1900). Yield 540 gallons an hour (1900).

		Thickness. Ft.	Depth. Ft.
Well [old ?] ...		—	35
[London Clay.]	Clay ...	53	88
	Blue clay ...	67	155
Grey sand and stone ...		$1\frac{1}{2}$	$156\frac{1}{2}$
Grey sand and clay ...		$15\frac{1}{2}$	172
[Reading Beds and Thanet Beds.]	Sand ...	14	186
	Mottled clay ...	9	195
	Green sand ...	33	228
	Grey sand ...	4	232
	Green sand ...	1	233
	Grey sand ...	41	274
	Green sand ...	5	279
[Upper] Chalk and flints ...		61	340

It is difficult to mark the base of the London Clay.

This account differs somewhat from that published in Dr. THRESH's 'Report on the Water Supply of Essex,' p. 28 (1901), which makes the depth to the Chalk 309 ft. For analysis of the water, see p. 402.

2. Crab's Hill.

About 111 ft. above Ordnance Datum (near a bench-mark).

Water-level 54 ft. down (1908). Yield appears to be 300 to 400 gallons an hour.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Gravel ...	9	9
[London Clay.]	Yellow clay ...	27	36
	Dark clay ...	10	46
	Clay-stone ...	2	48
	Dark clay ...	82	130
	Blue clay ...	20	150
[? London Clay.]	Clay and green sand ...	8	158
	Dark clay ...	14	172
	Sandy clay and shells ...	18	190

Hatfield Peverel, cont.

		Thickness. Ft.	Depth. Ft.
[? Reading Beds.]	Hard grey sand ...	4	194
	Live sand	6	200
	Clay	2	202
	Coloured sand	8	210
	Dark green sand ...	10	220
[? Thanet Sand.]	Grey sand	45	265
	Dark brown sand ...	13	278
	Dark green sand ...	2	280
	Light-grey sand ...	10	290
[Upper]	Chalk and flint	116	406

In this section also it is difficult to mark the base of the London Clay.

For analysis of the water, see p. 402.

Dr. THRESH, in his 'Report on the Water Supply of Essex, 1901,' p. 115, says:—"A serious outbreak of Typhoid Fever lately occurred, and the cause was no doubt contaminated water. The particular well (at a cottage) has been closed, but there are several others in the main street which are probably contaminated." His Report of 1905, p. 56, says the supply was almost wholly from private wells.

Havengore Island (? parish).

Ordnance Maps 258, 259 (Essex 79, NE. and NW.). Geologic Map 2.
Information from Mr. PURKIS to W. H. DALTON.
As at Foulness; but with 40 ft. less of London Clay.

Havering-atte-Bower.

Ordnance Map 257, new ser. (Essex 66, NE.). Geologic Maps 1, NW. and London District, Sheet 2.

1. Pyrgo Park. 1862.
Sunk and communicated by Messrs. S. F. BAKER and SONS.

		Thickness. Ft.	Depth. Ft.
[London] Clay		438	438
[Woolwich Beds, 48 ft.]	Shells in clay	4	442
	Green and black sand ...	29	471
	Sand and clay	10	481
	Pebbles	5	486
Hard [Thanet] Sand to chalk ...		47	533

2. Pyrgo Park. 1887.
Made and communicated by Messrs. ISLER.
Shaft 273 ft., the rest bored. 275 ft. of 6-in. tubes from 151½ ft. down; 385 ft. of 5-in. tubes from 151 ft. down.
Water-level 270 ft. down. Minimum yield about 700 gallons an hour.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	London Clay	273	273
	Blue clay	68	341
	Blue and loamy clay	12	353
	Blue clay, with claystone [septaria] 5-4 ft. from the bottom	62½	415½
	Loamy clay	5½	421
	[Basement-bed.] Blue clay with shells and pebbles	6	427
[Basement-bed, or Woolwich Beds ?]	Blue clay and sand	5	432
	Clay and shells	3½	435½
[Woolwich Beds, 55 ft.]	Green and black sand	41	476½
	Green sand	14	490½
[Thanet] sand and clay		38½	529
[Upper Chalk, 136½ ft.]	Chalk with water	73	602
	Grey impermeable chalk	63½	665½

For an analysis of the water, see p. 403.

Havering, cont.

Dr. Thresh says, in his Report on the Water Supply of Essex, 1901, p. 68, that there was one public pump; two houses had the South Essex Co.'s water; and the remainder depended on a shallow well, often dry in the summer, and polluted ponds.

Recently Lord O'Hagan has extended the mains of the South Essex Co. to supply the hall, the school, and adjacent cottages (1913).

Hawkwell.

Ordnance Map 258, new ser. (Essex 70, SW.). Geologic Maps 1, NE. and SE.

According to Dr. Thresh's Report of 1901, p. 79, the population was 300. Supplied by public shallow wells. Quality of the water generally good, but the quantity deficient in places.

The place is now supplied from the mains of the Southend Co. (1913).

Helion Bumpstead.

Ordnance Map 205, new ser. (Essex 4, SW.). Geologic Map 47.

1. Pale Green. For the Bumpstead Rural District Council. 1895 and 1906. From the Reports of the Medical Officer of Health, 1895 and 1896, and from Mr. G. Ingold, who deepened the well, which was made by Mr. Hook.

372 ft. above Ordnance Datum.
Well 4 ft. 3 in. in diameter inside the brickwork.
Water-level 157 ft. down, $156\frac{1}{2}$ ft. after deepening in 1896.
Depth of water in well, 7 ft.

[Glacial Drift.]	Boulder Clay ...	125	$167\frac{1}{2}$ ft.
	Sandy loam ...	$11\frac{1}{2}$	
	Chalk	31	

At the inspection after completion in 1895 (to 164 ft.) an accumulation of carbonic acid gas was met with. The Inspector was asphyxiated when about 80 ft. down, and fell to the bottom, dead. A man who went down to rescue him was also killed in the same way. At the inquest it was said that during the six months of construction no foul air was noticed.

The supply was inadequate, and in 1896 the well was deepened $3\frac{1}{2}$ ft. Before sinking could be done air had to be pumped in to replace the carbonic acid gas which filled the well up to about 30 ft. from the surface.

The depth of water when last measured (1896) had increased to 11 ft., 'and since then the water has probably risen' (1896), so that there was then an abundant supply.

To avoid pump-repairs in the foul air a bucket and wire-rope apparatus was installed.

2. In the village, at the four cross-roads below the church.
From the Report of the Medical Officer of Health to the Bumpstead Rural District Council. 1909.

289 ft. above Ordnance Datum.
Water-level 74 ft. down.

Boulder Clay ...	72	83 ft.
Chalk	11	

For an analysis of the water of the two wells, see p. 403.

The above wells form the chief source of supply; but, according to the Report of the Medical Officer for 1909, there are two other public pumps at White's Green and Wiggens Green, supplied with filtered pond-water.

A spring at the corner of Mill Road has been cleaned out and protected by a concrete wall. There are also a few private wells (Report for 1912).

Hempstead.

Ordnance Map 205, new ser. (Essex 10, NW.). Geologic Map 47.
Royal Oak Inn.
Sunk and communicated by Mr. G. Ingold.

[Boulder Clay.]	Brown clay ...	3	33 ft.
	Dark clay... ...	7	
	Light-blue clay ...	23	

Hempstead, cont.

According to Dr. Thresh's Report of 1901, p. 143, the public supply was from one reservoir and public fountain (fed by an enclosed spring), and from one pump and well, fed by a spring. There were several private wells.

Henham.

Ordnance Map 222, new ser. (Essex 14, SW.). Geologic Map 47.

1. Little Henham Lodge, northward of the village.
? About 285 above Ordnance Datum.
Old well about 90 ft. deep. Sand at the bottom.

2. Parsonage. About a sixth of a mile westward of Little Henham Hall.
Over 300 ft. above Ordnance Datum.
Made and communicated by Mr. G. Ingold.
Water-level 96 ft. down.

Boulder Clay ...	35	100 ft.
Chalk	65	

3. Pledgdon Green. 1887.
Made and communicated by Mr. G. Ingold.
Shaft throughout. Water-level 59 ft. down.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Brown clay	28	28
	Chalky drift	6	34
	Brown clay	11	45
	Blue clay	11	56
	White and yellow sand	6	62

It is possible that the lowest three beds may be Eocene.

4. Pledgdon Hall Cottages. 1896.
Made and communicated by Mr. G. Ingold.
Water at $14\frac{1}{2}$ ft.

[Glacial Drift.]	Gravelly [Boulder] Clay ...	7	17 ft.
	Yellow sand	10	

5. Close to Elsenham Station (? in Henham or Stansted). 1897.
Dr. A. Irving, *Prov. Geol. Assoc.*, vol. xv, p. 224.
300 ft. above Ordnance Datum.
Flinty gravel to Chalk, 90 ft.
Rubbly Chalk and pebbles of Carboniferous rocks brought up from the lower portion.

According to Dr. Thresh's Report of 1905, p. 52, the water of eight wells had been analysed and proved to be rather unsatisfactory, and the supply was limited in dry weather.

About 1902 or 1903, a well was sunk about 60 ft. without getting water: but after heavy rain water percolated in from the surface, and analysis proving that the well was liable to pollution, the water was only used for washing.

Henny (? Great and Little).

Ordnance Maps 206, 223, new ser. (Essex 12). Geologic Map 47.
Gentries Farm. (Gentrys.)
Made and communicated by Messrs. G. Isler & Co.
Water-level 150 ft. down. Yield, through a $2\frac{1}{2}$-in. pump, 180 gallons an hour

		Thickness. Ft.	Depth. Ft.
Shaft, through made ground and sand (the rest bored)		—	48
[Glacial Drift.]	Sand	$21\frac{1}{2}$	$69\frac{1}{2}$
	Ballast [gravel]	$6\frac{1}{2}$	76

Henny, cont.

			Thickness. Ft.	Depth. Ft.
[London Clay, 40 ft.]	Blue clay		32	108
	[Basement-bed]	Sand	$6\frac{1}{2}$	$114\frac{1}{2}$
		Hard ballast [? pebbles]	$1\frac{1}{2}$	116
[Reading Beds, 34 ft.]	Sand		$8\frac{1}{2}$	$124\frac{1}{2}$
	Clay		$1\frac{1}{2}$	126
	Sand		3	129
	Clay		21	150
[Thanet Sand, 10 ft.]	Dead dark sand		2	152
	Black sand		6	158
	Green sand		2	160
[Upper] Chalk			80	240

According to Dr. THRESH's Report of 1901, p. 139, supplies were got from ponds and a private spring. Dr. J. S. HOLDEN adds (1913) that there are several private wells, a deep one in the Chalk supplying several cottages near the church. In the valley the supply is got from shallow wells and springs.

Herts and Essex Waterworks Co. Established 1883.

Waterworks Directory, 1911, p. 171, and later information.

The well is in Sawbridgeworth, in Hertfordshire.

With the exception of that parish the places supplied seem to be all in Essex, as follows:—Bobbingworth, Chipping Ongar, Epping (and Coopersale), Greenstead, Harlow, High Ongar, Lambourne (and Abridge), Latton, Nazeing, Nettlewell, North Weald Bassett, Roydon, Sheering, Stanford Rivers, Theydon Bois, and Theydon Garnon. It also supplies the Hatfield Broad Oak Water Co.

The population supplied (including Herts) is about 15,000.

The yearly supply (? year ending 31st March, 1911) is 105,000,000 gallons.

Average daily supply per head:—domestic, 15 gallons; trade, 5·61.

Heybridge.

Ordnance Map 241, new ser. (Essex 54, NW.). Geologic Map 1, NE.

1. Bentall's Nut and Bolt Factory. (Heybridge Ironworks.) 1872.
(? about 1859, E. BENTALL.)

Information got by W. H. DALTON from Mr. BAHAM, well-sinker, and from specimens.

Shaft 75 ft., the rest bored. Maiden spring 90 ft. down.

Water-level when sunk, close to the surface; 15 ft. down in 1889; probably 25 ft. down in 1910.

Yield sufficient for the works and about 50 cottages.

			Thickness. Ft.	Depth. Ft.
[Valley] gravel			9	9
[London Clay.]	Clay		105	114
	Basement-bed.]	Sandstone ...	over 1	115
		Sand* [broken shell seen in some of this]	11	126

* [Some of this sand may belong to the Oldhaven or Reading Beds. The shells were decidedly from the basement-bed.]

For an analysis of the water, see p. 404.

Heybridge, cont.

2. Mr. Bentall's house, about 100 yds. from the above. 1872.

3. By the Churchyard. Same authority as above.

	(2)	(3)
[Valley] gravel	9 to 10	10 to 11 ft.
London Clay ...	116	115 ft.
Sandstone ...	a few ins.	a little
To sand and water	126	126 ft.

4. Heybridge Basin. Public well about 20 yds. north of Lock Gates.
About 12 or 15 ft. above Ordnance Datum.
Information from Inspector KEYWOOD.
Water-level about 15 ft. down.
Originally sunk and bored to a little over 100 ft. New bore, August, 1908.
Made by Mr. FURLONG.

Bottom of London Clay ... at $127\frac{1}{2}$ } Total, 140 ft.
In sand ... ... $12\frac{1}{2}$ }

Now (1900) lined with earthenware tubes.
Supply sufficient for 50 or 60 houses.
For analysis of the water, see p. 404.

5. Heybridge Hall. About 100 yds. from Navigation and opposite Maldon East Station.
New well (1908) made and communicated by Mr. SMITH.
About 16 ft. above Ordnance Datum.
Water-level 10 ft. down (Feb., 1908). Yield 600 gallons an hour (Feb., 1908).

		Thickness. Ft.	Depth. Ft.
[River] gravel ...		13	13
[London Clay.]	Yellow clay ...	1	14
	London Clay ...	106	120
[Oldhaven Beds.]	Sand and shells	8	128
	Pebbles ...	2	130
[Reading Beds and Thanet Beds.]	Coloured sandy clay	40	170
	Grey sand ...	62	232
	Dark green sand	2	234
	Flints ...	1	235
[Upper] Chalk ...		45	280

There is an old well here, then (Feb., 1908) being abandoned on account of infiltration of tidal (salt) water. The new well appeared to be subject to this also, see analysis, p. 404.

According to Dr. THRESH's Report on the Water Supply of Essex, 1901, p. 110, the greater part of the village was then supplied with excellent water from the bored well at the ironworks. There were several other bored wells and many shallow wells. Many of the latter showed signs of pollution. Heybridge Basin, a detached part of the village, was supplied by the local public well (No. 4).
The water-mains have since been extended from the well at the ironworks so as to supply the whole of Heybridge village.

High Easter.

Ordnance Map 240, new ser. (Essex 32, SE., 33, NW., 42, NE.).
Geologic Map 47.
Parsonage Farm. 1902?
Letter from Rev. E. GEPP to Mr. W. COLE.
"After sinking 50 feet or so . . the workmen were driven out by a strong escape of gas . . . at first with a roar audible some distance off, and afterwards (for a week altogether) more quietly. The gas exhausted, or nearly so, the work was carried a little deeper, but no water came." [? All Boulder Clay.]

According to Dr. THRESH's Report of 1901, p. 117, the chief supply was from a well 100 ft. deep. A group of cottages near the church got water from wells belonging to two inns. According to his Report of 1905, p. 59, the water-level in the public well fluctuated greatly, the well being chiefly fed by a land-spring. The parish was not satisfactorily supplied.

High Laver.

Ordnance Map 240, new ser. (Essex 41, SE.). Geologic Map 1, NW.

1. The School.

Information from Mr. W. H. PENNING.

[Glacial Drift.]	Boulder Clay ...	24	32 ft.
	Sand and gravel	8	

2. Rectory.

Communicated by Messrs. SMITH and Son.

Near 200 ft. contour-line. Water-level 50 ft. down.

The water was pumped out, 18th October, 1909. 200 ft. deep.

According to Dalton's Map, Chalk is just at Ordnance Datum. Therefore the water is probably from Chalk or from sands just above it.

For an analysis of the water, see p. 404.

High Roding.

Ordnance Map 240, new ser. (Essex 32, SE.). Geologic Map 47.

Dr. THRESH's Report of 1901, p. 117, says that the supply came from two public and many private wells, and that the public wells had been very low during the latter part of the summer.

Highwood (in the civil parish of Writtle).

Ordnance Map 240, new ser. Geologic Map 1, NE.

According to Dr. THRESH's Report of 1901, p. 105. Houses very scattered; some badly off for water. A public pump was provided in 1899, and a public well near the roadside had recently been improved and protected.

The water from the Boulder Clay here often smells of sulphuretted hydrogen.

Hockley.

Ordnance Map 258, new ser. (Essex 69, NE. and SE., 70, NW. and SW.). Geologic Map 1, NE.

Hull Bridge (by the River Crouch, north-westward of the village). For Messrs. Hobman & Co.'s Engineering Works. 1898? Abandoned.

Boring made and communicated by Messrs. ISLER.

Lined with 365 ft. of 6-in. tubes from the surface.

Water-level 75 ft. down. Supply 1,200 gallons an hour. Water said to be very good.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Light-brown clay	28	28
	Blue clay	237	265
	Brown clay	60	325
	Blue clay	25	350
	Blue clay and sand	5½	355½
	Hard sandstone	1	356½
	Mixed sands and blue clay ...	8½	365
	Pebbles	½	365½
	Grey sands	4½	370

According to Dr. THRESH's Report of 1901, p. 79, there was no public supply. The village depended on shallow wells, giving water of doubtful quality. One private bored well (that above) yielded only a limited quantity.

The supply is now taken from the Southend Co.

Horkesley, see **Great** and **Little Horkesley.**

Hornchurch.

Ordnance Map 257, new ser. (Essex 74, NE., SE., 75, NW.).
Geologic Map 1, SW.

1. The Schools.
Made and communicated by Mr. R. D. BATCHELOR.
Shaft 50 ft., the rest bored (small diameter).
Water from the Chalk, rose to within 75 ft. of the surface.

		Thickness. Ft.	Depth. Ft.
Soil		2	2
Gravel		10	12
[London Clay.]	London clay	38	50
	Clay and stone	27	77
	Strong clay	41	118
[? Reading Beds]	Clay, sand, and shells	22⅔	140⅔
	Hard sand	8⅓	149
[Reading Beds and Thanet Beds.]	Sand and clay	106	255
	Green clay, and chalk, with flints	3½	258½
[Upper Chalk, 300½ ft.]	Chalk with flints	186½	445
	Hard chalk with flints	50	495
	Chalk and flints	64	559

2. Beam Bridge. On the northern side of the road, just east of the river. About two-thirds of a mile south-east of Dagenham Railway Station. South Essex Waterworks Co. 1909.

Communicated by B. W. BRYAN.

Floor-level 11·6 ft. above Ordnance Datum. Shaft to Chalk.

		Thickness. Ft.	Ins.	Depth. Ft.	Ins.
Made ground		5	8	5	8
Soil		0	6	6	2
[Alluvial Beds and River Drift.]	Yellow clay	2	0	8	2
	Peat	1	0	9	2
	Dark sticky blue clay	7	6	16	8
	Light sticky blue clay	2	0	18	8
	Sticky green sand	1	0	19	8
	Ballast [gravel] and clay	5	0	24	8
[London Clay ? 25½ ft.]	Dark jointy brown clay	9	6	34	2
	Hard jointy brown clay	11	6	45	8
	Hard sandy dark clay	4	6	50	2
[? Oldhaven Beds and Woolwich Beds]	Hard sandy clay and shells	5	6	55	8
	Hard shells and sand	0	6	56	2
	Hard Blackwall Rock [conglomerate]	1	3	57	5
	Dark grey sand	0	6	57	11
	Sand and shells	20	0	77	11
	Fine grey sand	8	9	86	8
	Dark sticky sand	12	0	98	8
	Green sticky sand	0	6	99	2
	Dark sticky sand and small pebbles	2	6	101	8
	Clay stone	0	6	102	2
[Thanet Sand, 71½ ft.]	Dark grey live sand	7	0	109	2
	Very hard grey sand	59	6	168	8
	Dark sticky sand	4	0	172	8
	Dark green sand	0	6	173	2
	Green flints, to chalk	0	6	173	8

It is hard to fix either the base of the London Clay or that of the Woolwich Beds.

For an analysis of the water, see p. 405.

Horndon on the Hill.

Ordnance Map 257, new ser. (Essex 76, SW.). Geologic Map 1, SE.

1. Field, about 150 or 160 yds. north-westward of the church. Trial-boring for South Essex Water Co. 1900.

Made and communicated by Messrs. TILLEY (with notes from specimens in these brackets.) About 110 feet above Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
	Made ground [? soil] ...	2	2
[London Clay.]	Brickearth ...	13	15
	Brickearth and mica [selenite] ...	5	20
	Brickearth and mica, mottled, sandy	10	30
	Brickearth and mica, sandy ...	4	34
	Clay. (Pyrites and plant-remains at 48 ft.) ...	39	73
	Loamy clay ...	25	98
	[Basement-bed] Green sand, dark; shells and water	7	105
	[Basement-bed] Pebbles ...	1	106
[Oldhaven Beds and Woolwich Beds, 43½ ft ?]	Dead sand ...	6	112
	Dark sand (dirty brown loamy) ...	3	115
	Hard dark sand (grey) ...	11	126
	Dark green sand and pebbles (of flint)	1	127
	Dead loamy sand and pebbles (grey clay and sand) ...	1	128
	Dead green sand (clayey) ...	11	139
	Dark loamy sand (greenish-grey loam)	10½	149½
[Thanet Sand, 104 ft.]	Hard sand rock (fine grey sand, dry)...	8	157½
	Dead sand (as above, damp) ...	2½	160
	Lighter dead sand (greenish-grey, dry)	32	192
	Dead loamy sand (brownish-grey, damp) ...	23	215
	Dead loamy sand, sticky (as above, darker) ...	38	253
	Flints (some green-coated) ...	½	253½
Chalk.			

This work was abandoned.

2. Mr. Tyerell's (centre of village).
Information got by H. W. BRISTOW.

London Clay	Red (? brown) clay ...	17	100 ft.
	Clay ...	83	

According to Dr. THRESH'S Report of 1901, p. 70, there was a shallow well belonging to Rural District Council. Water was carted round at a farthing a pail. According to his Report of 1905, p. 27, the South Essex Co. then gave about 50 per cent. of the supply, 15 was from private wells, and the rest from the public pump.

Horsey, see Kirby le Soken.

Hullbridge, see Hockley.

Hutton.

Ordnance Map 257, new ser. (Essex 67, NE., 68, NW.).
Geologic Map 1, NE.

1. Hutton Place. On the high road westward of the village. Old well.
From W. H. DALTON.

[Glacial Drift.]	White marl ...	2 to 3	About 27 ft.
	Blue marl ...	7 to 8	
	Light-coloured strong loam ...	1½ to 2	
	Black sand ...	14 to 15	

Hutton, cont.

2. Rectory. Old well.
Information from Mr. Rolfe, the sinker, to W. H. Dalton.

Strong loam	7	19 ft.
Black sand and water, to London Clay	12	

According to Dr. Thresh's Report on the Water Supply of Essex, 1901, p. 83, the population was about 550; there was one deep well, the rest of the houses being supplied by shallow wells, some of which yielded a saline water. As many as twelve cottages used one pump.

The supply is now taken from the South Essex Co. (1913).

Ilford.

Ordnance Map 257, new ser. (Essex 65, SE., 66, SW., 73, NE., 74, NW.).
Geologic Maps 1, SW., and London District, Sheet 2.

1. Barking Side. Claybury Park Asylum. 1901.
Made by Messrs. Isler & Co. Communicated by W. C. Smith.
230 ft. above Ordnance Datum.
Lined with 8 ft. of 18-in. tubes from 14 ft. down, 190 ft. of 13½-in. tubes from 99 ft. down, and 410 ft. of 11½-in. tubes from 7 ft. down.
Water-level, when made, 226 ft. down. Yield only 200 gallons an hour.
Not used.

		Thickness. Ft.	Depth. Ft.
Made ground ...		5	5
[London Clay.]	Brown clay ...	26	31
	Blue clay with layers of claystone ...	275	306
	Green sand ...	12	318
	Chalk [? stone] ...	2	320
[Reading Beds, 50 ft.]	Mottled clay and green sand ...	5	325
	Green sand and pebbles ...	29	354
	Light-green sand and shells ...	26	380
[Thanet Sand, 26 ft.]	Dark grey sand ...	25½	405½
	Green coated flints ...	½	406
[Upper] Chalk ...		109	515

The greensand and the stone below may belong to the Reading Beds instead of to the London Clay, and the Thanet Sand may reach higher.

2. Barking Side. Mission Home. 1876.
Sunk and communicated by Messrs. Docwra and Son.
Shaft 72 ft., the rest bored. Water-level about 66 ft. down.

		Thickness. Ft.	in.	Depth. Ft.	in.
Surface soil ...		2	6	2	6
[Valley Drift, 10 ft.]	Loam and sand	2	0	4	6
	Running sand ...	6	8	11	2
	Gravel ...	1	4	12	6
[London Clay, 143¾ ft.]	Yellow clay ...	2	6	15	0
	Blue clay ...	141	3	156	3
Grey [Oldhaven ?] sand ...		11	0	167	3
[Woolwich Beds], Green sand ...		25	0	192	3
Dark grey Thanet Sand ...		? 51	0	243	3
[Upper] Chalk and flints ...		145	0	388	3

3. Dr. Barnardo's Village Homes.
Made and communicated by Messrs. Batchelor.
Information from the Governor adds that the boring is of 12 in. diameter and the rest-level of the water 116 ft. down.

		Thickness. Ft.	Depth. Ft.
Dug Well (the rest bored) ...		—	92¾
[London Clay ?]	Clay ...	52	144¾
	Clay and sand ...	18	162¾

Ilford, cont.

		Thickness.	Depth.
[Lower London Tertiaries.]	Sand and clay ...	19	181¾
	Sand	9	190¾
	Grey sand ...	6	196¾
	Sand and chalk	10	206¾
	Sand	15	221¾
	Sand and chalk	12	233¾
[Upper] Chalk and flint		251¼	485

For an analysis of the water, see p. 408.

4. Britannia Works (Mr. A. H. Harman's, now the Ilford Limited). 1885.
Made and communicated by Messrs. Le Grand and Sutcliff.
Shaft 27 ft., the rest bored. Water-level 23 ft. down.

		Thickness. Ft.	Depth. Ft.
Dug well [? Gravel, etc.]		—	27
Blue [London] Clay		59	86
[Woolwich and Reading Beds, 21 ft.]	Clay and shells	4	90
	Dead, green sand ...	12½	102½
	Black pebbles	½	103
	Dark, dead sand ...	4	107
[Thanet Sand, 56½ ft.]	Live sand and water ...	35	142
	Dead sand	20	162
	Flints	1½	163½
[Upper] Chalk and flints		128½	292

For an analysis of the water from a well here (325 ft. deep), see p. 406.

5. Broadway.
Dr. J. Mitchell's MSS., vol. iii, p. 71.
Dug 63 ft., the rest bored. Water rose to within 30 ft. of the surface.

			Thickness. Ft.	Depth. Ft.
[River] Gravel and yellow clay			10	10
[London Clay.]	Blue clay		93	103
	[?Basement-bed]	Water-rock ...	2	105
		Black pebbles, with a very little sand	3	108
[Reading Beds.]	Yellow clay		8	116
	To sand and black pebbles, with much water.			

6. Downhall Farm (Butler's of old one-inch map) off the Romford Road, about midway to Chadwell Heath. 1878.
About 50 ft. above Ordnance Datum.
Made and communicated by Messrs. Le Grand and Sutcliff.
Bored throughout. Water-level 27 ft. down. Yield 8 gallons a minute (? 4,000 in 10 hours.)

		Thickness. Ft.	Depth. Ft.
[River] Gravel		15	15
Blue [London] Clay		35	50
[Woolwich and Reading Beds, 55 ft.]	Sand	10	60
	Stone	6	66
	Coloured [mottled] sand	9	75
	Green sand	6	81
	Blue sand	3	84
	Dark sandy clay ...	6	90
	Sand	5	95
	Black pebbles	10	105
[Thanet Sand, 47 ft.]	Sand, the top 4 ft. coarse	20	125
	Loamy sand	3	128
	Dead sand	24	152
[Upper] Chalk		56	208

Ilford, cont.

7. Near the row of houses opposite the Red House.
Dr. J. MITCHELL'S MSS., vol. iii, p. 72.
Dug 87 ft., the rest bored.
Water abundant, and rose within 52 ft. of the surface.

Old well	58	
Blue [London] Clay	241	301 ft
Sand and black pebbles [basement-bed of London Clay]	2	

8. Redbridge Cottage. 1891.
Information from Messrs. LE GRAND and SUTCLIFF.

		Thickness. Ft.	Depth. Ft.
Dug well	...	—	20
Blue [London] clay	...	46	66
[? Blackheath or Woolwich Beds]	Dead grey sand, pebbles and shells ...	6	72
	Peaty sand and shells ...	2	74
[Woolwich Beds]	Black clay and shells ...	8	82
	Dead grey sand and shells ...	3½	85½
	Hard green sand ...	4½	90
	Greenish sand and pebbles ...	2½	92½

The ending off of the Woolwich Beds in this and in the Downhall well (6) is somewhat doubtful.

This section seems to throw doubt on the figures given by Dr. Mitchell in No. 7. Should these, however, be right, then Mr. DALTON is right in saying that "the proximity of the base of the London Clay, coupled with its being 300 feet close by, proves the correctness of the position assigned [by him] to the Roding Valley fault (in the map in the *Essex Naturalist*, vol. v, pl. iii), a fault detected wholly by calculation, and now fixed within 100 yards limit of error."

9. Chadwell Heath. West Ham Asylum.
Made by Messrs. ISLER. Communicated by the Medical Officer of Health for West Ham.

A 6-in. boring. Made in 1900 (not finished, 5th Dec., 1900, when the following information was sent):—

84·5 ft. above Ordnance Datum.
On 5th Dec., 1900, water-level was 74 ft. down.

Yield. A fortnight's continuous pumping at 7,000 gallons an hour did not reduce the water-level. But after three weeks' *cessation* of pumping the water-level was only 60 ft. down, Dec., 1900.

		Thickness. Ft.	Depth. Ft.
[River Gravel] Ballast	...	18	18
[London Clay, 111½ ft. ?]	Brown clay ...	1½	19½
	London Clay ...	105	124½
	Clay-stone ...	1½	126
	Clay and shells, and thin pebble-bed...	13½	139½
[Reading Beds.]	Green clay ...	26	165½
	Hard green sand ...	10½	176
[Thanet Sand.]	Live fellet (?) sand ...	36	212
	Green-coated flints ...	1	213
[Upper] Chalk	...	137	350

For an analysis of the water, see p. 405.

10. Paper Mills. Eckman Pulp Co. At river-bridge, near Ilford Railway Station.

A well 80 ft. deep used to yield 7,260 gallons an hour, day and night.

Newer well (about 30 years old, 1900) 280 ft. deep used to yield about 5,000 gallons an hour. Now (1900) only 3,000.

The water-level (newer well), originally 18 ft. down, was 81 ft. down in 1900, a reduction of 63 ft. in 30 years or so, mainly in the last three or four years. Also the water has got harder.

For an analysis of the water (? from the newer well), see p. 406.

Ilford, cont.

The South Essex Waterworks Co. has three pumping-stations in Ilford, the following accounts of which are now printed for the first time, through the kindness of B. W. BRYAN, Engineer to the Company. Nos. 11–13.

11. Mill Road. Western end of Ilford Railway Station, close to the river, the railway and the road. For the South Essex Waterworks Co. 1905.
Floor-level 19½ ft. above Ordnance Datum. Shaft to Chalk.

		Thickness. Ft.	ins.	Depth. Ft.	ins.
Made ground		11	6	11	6
[River Drift.]	Mixed clay	4	0	15	6
	Dirty clay (ballast [gravel] and sand)	8	0	23	6
	Dark green sand	3	0	26	6
[Woolwich Beds, about 29 ft.]	Blue clay	10	0	36	6
	Light-blue clay and cockle- and oyster-shells	2	0	38	6
	Light-green sandy clay	1	6	40	0
	Dark green sandy clay	1	0	41	0
	Mottled green sand	4	0	45	0
	Dark grey loamy sand	7	4	52	4
	Sharp sand and black pebbles	0	6	52	10
	Dark grey sand and black pebbles	2	6	55	4
[Thanet Sand, 59 ft.]	Light-grey quick sand	10	0	65	4
	Light-grey sand (dry)	25	0	90	4
	Very dark sand (loamy and dry)	23	8	114	0
	Flints	0	6	114	6
To Chalk					

For analyses of the water, see p. 407.

12. Woodford Bridge Road. Roding Pumping Station. Opposite Fernhall Farm, north-west of the town. For the South Essex Waterworks Co. 1905.
31·75 ft. above Ordnance Datum. Shaft to Chalk.

		Thickness. Ft.	In.	Depth. Ft.	In.
Made ground		3	2	3	2
Soil		2	6	5	8
[River] Gravel		9	0	14	8
London Clay		78	6	93	2
[Woolwich Beds, 48 ft.]	Hard dirty sand	10	0	103	2
	Clay, stone and shells	6	0	109	2
	Yellow sand	11	0	120	2
	Pebbles	1	0	121	2
	Green sand	20	0	141	2
[Thanet Sand, 43 ft.]	Fine grey sand	15	6	156	8
	Fine dark sand	14	0	170	8
	Dark loamy sand	14	6	185	2
To Chalk					

For an analysis of the water, see p. 407.

13. Goodmayes (? Chadwell Heath). On the western side of Grove Road, just south of the isolation hospital. For the South Essex Waterworks Co. 1910.
Ground-level 74·5 ft. above Ordnance Datum. Shaft to Chalk.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil		2	0	2	0
[River Gravel]	Ballast and sand	8	6	10	6
[London Clay.]	Brown clay	2	0	12	6
	Jointy London Clay	11	6	24	0
	Clay-stone with water	0	6	24	6
	London Clay	5	0	29	6
	Light-coloured live clay and drift wood	0	6	30	0
	Hard London Clay	48	0	78	0
	Clay-stone	0	6	78	6

Ilford, cont.

		Thickness. Ft.	In.	Depth. Ft.	In.
[? London Clay.]	Hard grey sand and clay-stone ...	5	0	83	6
	Clay-stone 7 ins., and hard rock 14 ins.	1	9	85	3
[? Oldhaven Beds]	Grey sand and shell	1	3	86	6
	Hard grey sand stone	1	8	88	2
	Hard shell and grey sand	0	7	88	9
	Hard grey sand stone	0	6	89	3
	Hard shell and grey sand	0	6	89	9
	Hard grey stone	1	0	90	9
[Woolwich Beds]	Hard clay and shell	8	3	99	0
	Hard sand	2	6	101	6
	Coloured sand (little water)	1	0	102	6
	Coloured rock (very hard)	3	6	106	0
	Live coloured sand	5	0	111	0
	Sticky sand	7	0	118	0
	Oyster-shell and pebbles	0	6	118	6
	Hard dark sticky sand	8	6	127	0
[Thanet Sand, 55½ ft.]	Fine light-coloured, hard sand ...	20	0	147	0
	Hard dark sand	35	0	182	0
	Green flints	0	6	182	6
To Chalk.					

For details of the following Ilford borings, see the Memoir on London Wells, by G. Barrow, 1912, pp. 93, 98-100. There are differences in the classification:—

14. Great Eastern Railway. Engine-sheds, Sams Green. 1900.
45 ft. above Ordnance Datum.
Water-level 24 ft. below O.D. Yield 4,000 gallons an hour.

	Thickness. Ft.	Depth. Ft.
Made ground and River Drift ...	31	31
London Clay ?	7?	38
Woolwich Beds and Thanet Sand ...	82?	120
Upper Chalk	230?	350

For an analysis of the water, see p. 406.

15. Electricity Works. Ley Street. 1901.
45 ft. above Ordnance Datum.
Water-level, at rest, 45 ft. below O.D., while pumping, 85.

	Thickness. Ft.	Depth. Ft.
Made earth and River Gravel ...	19	19
London Clay	53	72
Woolwich Beds and Thanet Sand ...	87	159
Upper Chalk	253	412

For an analysis of the water, see p. 406.

16. Roden Street. South Essex Laundry. 1908.
35 ft. above Ordnance Datum.
Water-level 70 ft. below O.D. Supply 2,500 gallons an hour.
Cavities in the Chalk at 321, 331 and 356 ft.

	Thickness. Ft.	Depth. Ft.
Made ground, soil and gravel ...	7⅔	7⅔
London Clay	54	61⅔
Woolwich Beds and Thanet Sand ...	85	146⅔
Upper Chalk	213¼	360

Ilford, cont.

17. Gas Works. 1906.
11 ft. above Ordnance Datum.
Water-level 80 ft. below O.D. in 1911. Supply 2,700 gallons an hour.

	Thickness. Ft.	Depth. Ft.
Soil and River Drift ?	24⅔	24⅔
Woolwich Beds and Thanet Sand ...	81⅓	106
Upper Chalk	207	313

18. Uphall Road. Messrs. Howard's Chemical Works (include the old Lavender Mount). 1898.
20 ft. above Ordnance Datum.
Water-level 56 ft. below O.D. in 1898. Supply 3,000 gallons an hour in 1898, 1,080 in 1911.

	Thickness. Ft.	Depth. Ft.
Soil and River Gravel	28	28
London Clay	21	49
? Oldhaven Beds, Woolwich Beds and Thanet Sand	91	140
Upper Chalk	235	375

For an analysis of the water, see p. 406.

19. Ilford Laundry. Ley Street. 1899.
About 45 ft. above Ordnance Datum.
Yield 3,000 gallons an hour.

Gravel	10	300 ft.
London Clay and Lower London Tertiaries	151	
Upper Chalk	149	

20. Chadwell Heath Asylum. Goodmayes. 1900.
84 ft. above Ordnance Datum.
Water-level 10 ft. above O.D. Supply 6,000 gallons an hour.

	Thickness. Ft.	Depth. Ft.
Made ground and River Gravel ...	23	23
London Clay	93½	116½
Woolwich Beds and Thanet Sand ...	92½	209
Upper Chalk	143	352

The account given by Dr. Thresh in his Report on the Water Supply of Essex, 1901, pp. 28, 29, which presumably refers to this well, gives different figures.

Ingatestone, in the ecclesiastical parish of **Fryerning.**

Ordnance Maps 240, 257, new ser. (Essex 60, NW. and SW.).
Geologic Map 1, NE.

According to Dr. Thresh's Report on the Water Supply of Essex, 1901, pp. 102, 103, Ingatestone and Fryerning had a public supply from a chain of wells in the Bagshot Sand. The water was collected in reservoirs and filtered through sand, polarite and flannel. Although slightly turbid it was of good quality and very soft. The supply was intermittent.

This is one of those supplies got from the opening out of springs by shallow wells (see also p. 78).

The supply now comes from the deep boring, see below.

1. For the Chelmsford Rural District Council. Waterworks, on the northern side of the road about a third of a mile east of Fryerning Church. 1902.

Proc. Geol. Assoc., vol. xix, pp. 317, 318. Communicated by Mr. James Dewhirst. (Remarks in these brackets from Messrs. Le Grand and Sutcliff, who made the boring.)

255 ft. above Ordnance Datum.

Ingatestone, cont.

Lined originally with 10-in. tubes from surface to 534 ft. down, $8\frac{1}{2}$-in. tubes from 536 ft. to 696 ft. down, and $7\frac{1}{4}$-in. tubes from 696 ft. to 766 ft. down, the rest being unlined.

A well has been dug round the bore-hole to a depth of 350 ft.

The following figures are from Messrs. LE GRAND and SUTCLIFF:—Water-level 198 ft. down originally, 15th Dec., 1901. About 14 days' continuous pumping, at the rate of 40,000 gallons in 24 hours, reduced this to 300 ft. down (Dec., 1901). The water-level recovered as follows, after pumping was stopped: In $1\frac{1}{2}$ hours to $245\frac{1}{2}$ ft. down, in $1\frac{3}{4}$ to $241\frac{1}{2}$, in $7\frac{1}{2}$ to $235\frac{1}{2}$, in $23\frac{1}{2}$ to $226\frac{1}{2}$, in 47 to 219, in 72 to $215\frac{1}{2}$, on the 4th day to $212\frac{1}{2}$, and on the 9th day to 205. For analyses of the water, see p. 408.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift]	Gravel and sand	2	2
[London Clay.]	Sandy loam	$4\frac{1}{2}$	$6\frac{1}{2}$
	Blue clay	$\frac{3}{4}$	$7\frac{1}{4}$
	Sandy loam	$12\frac{3}{4}$	20
	Blue sandy clay...	7	27
	Blue clay and clay-stones (septaria) ...	31 (33)	58 (60)
	Blue clay, small stones, etc. (with water)	32 (22)	90 (82)
	Blue clay	418 } (434)	508
	Blue clay and shells	8 }	516
	Sandy clay (blue: pebbles at base) ...	16	532
[? Oldhaven Beds and Reading Beds.]	Hard sand and pebbles	2	534
	Hard sand	$23\frac{1}{2}$	$557\frac{1}{2}$
	Sand and shells	$7\frac{1}{2}$	565
	Clay and shells	3	568
	Undescribed	1	569
	Stone	$\frac{1}{2}$	$569\frac{1}{2}$
	Sand peat [lignite] and clay	$8\frac{1}{2}$	578
	Sand (green)	9	587
	Green sand and brown clay	10	597
[? Thanet Beds.]	Greenish sand and small shells [carried down ?]	49 ($50\frac{1}{2}$)	646 ($647\frac{1}{2}$)
	Flints	$\frac{1}{2}$	$646\frac{1}{2}$
[Upper Chalk.]	Chalk and flints	76	$722\frac{1}{2}$
	Rubble chalk	7	$729\frac{1}{2}$
	Chalk, with bed of flints at 765 to 766 ft.	$70\frac{1}{2}$	800

The great interest of this section is that it shows a much greater thickness of London Clay than has been proved before, and even a greater total thickness than has ever been estimated. This is the more notable as the very topmost beds of that formation are here absent. On the other hand the Lower London Tertiaries, with a total thickness of $114\frac{1}{2}$ ft., are thinner than one would have expected here. Even if the last two beds classed with the London Clay be removed into this series, still the former will be of much greater thickness than before known.

No water was found in the Thanet Beds, nor on getting into the Chalk. Abandonment was contemplated, but Dr. THRESH urged continuation of boring, and at near 800 ft. depth a limited amount of water was got.

According to the Water Works Directory, 1911, p. 82, the population supplied was about 1,300 and the quantity of water in 1910 was 9,333,700 gallons.

2. Mr. Parry's. 1903.

Made and communicated by Messrs. ISLER.

Lined with 435 ft. of 4-in. tubes from 1 ft. down. Water-level 122 ft. down.

		Thickness. Ft.	Depth. Ft.
Dug well		—	22
[London Clay.]	Blue clay	26	48
	Sandy clay	57	105
	Blue clay and stone ...	9	114
	Sandy clay	323	437
[?Oldhaven Beds.]	Grey sand	11	448
	Sand and pebbles ...	3	451

Ingrave.

Ordnance Map 257, new ser. (Essex 67, NE. and SE., 68, NW.).
Geologic Map 1, NE.
Dr. THRESH's Report on the Water Supply of Essex, 1901, p. 83.
Water-supply got from shallow wells, some of which fail in the summer.
The South Essex Co. is arranging to supply.

Inworth.

Ordnance Map 241, new ser. (Essex 35, SE. and NE.). Geologic Map 47.

1. Inworth Grange. Well 26 ft. deep. For analysis, see p. 409.

2. For the Public Supply of Tiptree. In a field behind Brook House, near the boundary of Tolleshunt Knights and ⅓ of a mile west of Tiptree Church.
Near the 200 ft. contour-line.
Water-level about 5 ft. down. Yield 20,000 gallons a day.
20 ft. deep; sand and (Plateau) gravel throughout.
For an analysis of the water, see p. 408.
The local supply is from shallow wells.

Kelvedon.

Ordnance Map 223, new ser. (Essex 59, NW.). Geologic Map 47.

1. Felix Hall.
Information from Mr. J. HATLEY.
Supply 18,000 gallons in 24 hours. Water-level about 28 ft. down.

London Clay ...	130	162 ft.
Sand	2	
Red clay, to red sand	30	

2. Mr. Fuller's Brewery, by the bridge. 1887.
Made and communicated by Messrs. ISLER, and from an account by G. F. BEAUMONT, *Essex Naturalist*, vol. i, p. 189. (The figures in brackets from a later account.)
88 ft. above Ordnance Datum.
Well 8 ft., the rest bored. The boring lined with 275 ft. of 4-in. tubes.
Water rose 6 ft. above the ground. (? 4 ft. down later.) (In 1899 Messrs. FULLER said water-level still unchanged.)
Yield about 300 gallons an hour.

		Thickness. Ft.	Depth. Ft.
Made ground		2	2
Coarse ballast [Post-Glacial gravel] ...		32	34 (32)
Boulder Clay (Blue clay, stone and chalk) ...		160 (158)	194 (190)
Blue [? London] clay		19 (22)	213 (212)
[Reading Beds and Thanet Beds.]	Dead green sand ...	1	214
	Dead brown sand ...	15	229 (228)
	Live sand with water ...	2 (6)	231 (234)
	Dead brown sand ...	35½ (34)	266½ (268)
	Flints	½	267
[Upper] Chalk, more or less with flints ...		116	383 (378)

The great thickness of Boulder Clay in this section is remarkable. Can it be that some part assigned to this may be really London Clay? It is hard also to understand the beds below the blue clay. The top foot of sand may be the basement-bed of the London Clay (presuming that the blue clay belongs to that formation, and not to the Reading Beds). From the other beds, down to the flints, being all sand, one cannot fix the division between the Reading Beds and the Thanet Beds.

For an analysis of the water, see p. 410.

In 1905 Kelvedon depended on one public pump and a number of private wells, those through the London Clay yielding water readily. It is now supplied from the Coggeshall Waterworks.

Kirby le Soken.

Ordnance Map 224, new ser. Geologic Map 48, SE.

1. Made and communicated by Messrs. DUKE and OCKENDEN. 1907.
Lined with 4½-in. tubes to 185 ft. down.
A fissure containing water was struck at 220-222½ ft. down.
Water-level 26 ft. down.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Light-coloured brickearth ...	9	9
	Dark brickearth	50	59
[Mostly London Clay]	Platimore clay	70	129
[Reading Beds.]	Mottled clay	5	134
	Green clay	5	139
	Mottled clay	14	153
	Marl	1½	154½
	Layer of green flints	½	155
[Upper] Chalk ...	... ...	70	225

2. Horsey. New House Farm. 1909.
Made and communicated by Messrs. DUKE and OCKENDEN.
Lined with 4½-in. tubes to 144 ft. down.
Water-level 2 ft. down.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Dark clay	15	15
	Stone lime	9	24
	Brown clay	23¼	47¼
[Reading Beds.]	Fine sand (with salt water) ...	5	52¼
	Various coloured clays ...	36	88¼
	Fine sand	2½	90¾
	Limestone rock	1½	92¼
	Fine sand (salt water) ...	5	97¼
	Clay	1½	98¾
	Sand	2¼	101
	Blue clay	23	124
	Green clay	4	128
	Red clay	7	135
	Green clay	7	142
	Flints	2	144
[Upper] Chalk and flints	... ...	31	175

Probably too great a thickness is given to the Reading Beds.

Kirby was largely supplied by the Tendring Hundred Water Co. Lower Kirby has a gratuitous supply, the gift of the late Mr. BLANCHARD, which is good and plentiful. (Dr. THRESH's Report of 1901, p. 127.) It is got from a spring, the water of which is piped into the village.

Kynochtown, see **Stanford le Hope.**

Laindon.

Ordnance Maps, 257, 258, new ser. (Essex 68, SE.). Geologic Map 1, SE.

1. Railway Station, close to road. 1888.
Bored and communicated by Messrs. LE GRAND and SUTCLIFF.
About 148 ft. above Ordnance Datum. Water-level 122 ft. down (1888).

			Thickness. Ft.	Depth. Ft.
[London Clay.]	Blue clay	... ...	291	291
	Sandy clay	... ...	51	342
	[Basement-bed ?]	Green sand and water	1	343
		Black pebbles and sand	2	345

Laindon, cont.

		Thickness.	Depth.
[? Woolwich Beds, 48 ft.]	Green sand	7	352
	Blowing sand	14	366
	Sandy clay	3	369
	Green blowing sand	13	382
	Clay and stones [? pebbles]	5	387
	Green sand	6	393
[? Thanet Beds, 90 ft.]	Hard clay and sand	17	410
	Dead green sand	18	428
	Green sandy clay	22	450
	Green sand and clay	33	483
[Upper] Chalk, 305 ft.	Grey putty-chalk [very soft]	42	525
	Soft, whiter chalk, and flints	37	562
	White chalk and flints	94	656
	Sticky chalk and flints	10	666
	White chalk and flints	43	709
	Grey chalk and flints	5	714
	White chalk and flints	5	719
	Hard white chalk	4	723
	Grey putty chalk [very soft], and flints	51	774
	White chalk and flints	4	778
	Light-coloured, hard chalk and flints	4	782
	Dark, sticky chalk and flints ...	6	788

For an analysis of the water, see p. 410.

2. Near new Hotel and Railway Station. For public supply? 1897.
Information from Messrs. POLLARD and TINGLE.
About 146 ft. above Ordnance Datum.
Rest-level of water 111½ ft. down. The well ends in a 6-in. bore-hole.
Yield 400 gallons an hour.

To bottom of London Clay ...	328	} 336 ft.
Sand and pebbles with water ...	8	

The Southend Co. has bought this well, but does not use it.
For analysis of the water, see p. 410.

According to Dr. THRESH's Report of 1901, p. 83, the population was then only 350, and the village was very badly off for water, many of the houses depending on ponds or rain-water. Some of the farms had to cart water two miles.

The supply is now in the hands of the Southend Water Co. (1913).

Laindon (or Langdon) Hill.

Ordnance Maps 257, 258, new ser. (Essex 76, NW. and NE.).
Geologic Map 1, SE.

This is a distinct parish, in the Orsett Rural District, whilst Laindon is in the Billericay Rural District.

According to Dr. THRESH's Report on the Water Supply of Essex, 1901, p. 70, the population was then 220, and the supply, probably the worst in the district, was derived from two springs, one of which rises in an unprotected pool. Water was carted and sold at a halfpenny a pail.

In 1905, 35 per cent. of the supply came from springs, 30 from shallow wells, and the rest from rain-water.

The supply is now taken from the Southend Co. (1913).

1. Brickyard. Mr. C. T. Johnson.
Dr. A. E. SALTER, *Proc. Geol. Assoc.*, vol. xx, p. 181.
About 300 ft. above Ordnance Datum.
27 ft. deep, chiefly in London Clay.
A good supply got after passing a bed of septaria.

I have a note of 1907 that there was about 1½ ft. of water in the well at the brickyard just west of Butler's Grove, about 26 ft. deep, probably the same.

Laindon Hill, cont.

2. Trial-well ($7\frac{1}{2}$ ft. diameter) for public supply, in field 174, on the hill, northward of Combe Wood. 1907.

From the foreman on the spot, the last bed from Mr. HILL WILLIS (later), who says that there was 2 ft. 4 in. of water. Yield 3,500 gallons a day for 14 days.

		Thickness. Ft.	Depth. Ft.
Light soil	...	1	1
[Bagshot Sand.]	Mild yellow loam	5	6
	Grey loam	4	10
	Yellow loam	$5\frac{1}{2}$	$15\frac{1}{2}$
	Yellow loam [clayey fine sand]	$4\frac{1}{2}$?	$19\frac{1}{2}$
	Grey sand	$11\frac{3}{4}$	$31\frac{1}{4}$
	Clay	$\frac{1}{4}$	$31\frac{1}{2}$
	Red sand getting clayey below; some pipe-clay being turned out ...	$2\frac{3}{4}$	$34\frac{1}{4}$
	Loam and sand with streaks of clay (grey)	$5\frac{1}{4}$	$39\frac{1}{2}$

For an analysis of the water, see p. 410.

3. Mr. Morley Hill's Estate.
Information from Mr. W. GILBERT. 1888.
200 ft. eastward of pit in Bagshot Sand.

Well of $3\frac{1}{2}$ ft. diameter in Bagshot Sand. Top 308 ft. above Ordnance Datum. 16 ft. deep. Water rises to 303 ft. above O.D., and is little affected by season or weather.

A main, starting at about 4 ft. from the bottom, leads the water to the house. 960 gallons a day drawn off thus, by gravitation. A tank in rear of the stables is first supplied and, when this is full, a large tank at the back of the house, from which a fountain in the garden plays day and night, and there is an overflow (besides this) to an underground tank.

This is an interesting case of a private supply.

4. I have a note, dated Sept., 1907, of a reservoir in Well Wood, at the northern edge of which a well was being made. This is in London Clay and I presume has been abandoned. The spot is about 1,000 yds. east of south from Laindon Railway Station.

Lamarsh.

Ordnance Map 223, new ser. (Essex 12, SE.). Geologic Maps 48, NW. and 47.

Most of the houses get good water from a stream; but there are several private wells.

Lambourne.

Ordnance Map 257, new ser. (Essex 58, SW. and SE.). Geologic Maps 1, NW., and London District, Sheet 2.

Abridge. Messrs. Hargreaves' Brewery, at the back of the Blue Boar. 1888.
The Engineer, vol. xlvi, p. 206.
Water-level 37 ft. down. Yield over 1,500 gallons an hour.
Well, $9\frac{3}{4}$ ft., the rest bored.
Lined with 330 ft. of $7\frac{1}{4}$-in. tubes from $4\frac{1}{2}$ ft. down. Abandoned.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Blue clay	227	227
	Hard sandy clay	9	236
	Sandy clay and pebbles [Basement-bed]	8	244
[Woolwich and Reading Beds, and Thanet Sand.]	Mixed coloured sand, clay, shells and pebbles	20	264
	Green sand	12	276
	Dark green sand and pebbles [? the pebbles carried down]	50	326
[Upper] Chalk, with water in the first 100 ft.	...	110	436

Lambourne, cont.

A somewhat different short account was given by Mr. W. Willett and printed by mistake as of another well, in the Memoir on the Geology of London, vol. ii, p. 12.

Lambourne is now supplied by the Herts and Essex Co. (1913).

Langenhoe.

Ordnance Maps 224, 242 (Essex 36, SE., 37, SW.). Geologic Map 48, SW.
Langenhoe Hall (in map 242). 1902.

Water-level 38½ ft. down. Chalk reached at 235 ft. Bored to 300 ft.

No section kept, but said to be much like one at Abberton Hall (see p. 85).
Two farms and a pond supplied.
For analysis of the water, see p. 411.

Dr. J. W. Cook's Report for 1900, repeated in Dr. Thresh's Report of 1901, p. 134, says that this parish was very badly off for water. There were practically no wells, and water, carted from springs at Abberton and Fingringhoe, was sold by the pailful.

Dr. Cook says that there is a well at Langenhoe Wick, 300 ft. deep, and another deep well at Pete Tie Hall, near by (just over the parish-boundary).

Langford.

Ordnance Map 241, new ser. (Essex 45, SW., 54, NW.).
Geologic Map 1, NE.
Given as Longford in Dr. J. Mitchell's MSS., vol. iii, p. 80.
Water rose 5 ft. above the ground.
Through [London] clay to fine sand with shells, 150 ft.

According to Dr. Thresh's Report of 1901, p. 110, Langford was chiefly supplied from two public wells, both yielding doubtful water. Cottages at a distance from these used ditch-water.

Langham.

Ordnance Map 224, new ser. (Essex 19, NW. and SW.).
Geologic Map 48, NW.

Dr. J. W. Cook says that the supply is from shallow wells, largely in gravel, with a bed of clay in the middle.

Langley.

Ordnance Map 222, new ser. (Essex 8, SW.). Geologic Map 47.

According to the Report of the Medical Officer for 1912, there are two public pumps, one on Upper Green and one on Lower Green, getting water from wells in Boulder Clay (about 45 ft. deep).

Latchingdon.

Ordnance Maps 241, 258, new ser. (Essex 62, NE. and SE.).
Geologic Map 1, NE.

1. Tyle Hall. Tiled Hall of old map, east of St. Michael's. 1888.
Bored and communicated by Messrs. Le Grand and Sutcliff.
Over 171½ ft. above Ordnance Datum. Water-level 168 ft. down.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Brickearth	33	33
	Blue clay	409	442
	Blue sandy clay...	25	467
	[Basement-bed.] Sand and shells ...	1	468
	[Basement-bed.] Sand and pebbles ...	4	472
Reading Beds.]	Dead sand	3	475

For analysis of the water, see p. 411, where Dr. Thresh remarks that if the above section is correct the Reading Beds here give a water exactly like that of the Thanet Beds.

Latchingdon, cont.

2, 3. Old Wells.

Young's Agriculture of Essex, vol. i, p. 24.

At the angle of the road, $\frac{1}{4}$ mile east of the Lion Inn. London Clay, 350 ft.
Public well, for the use of Snoreham and Latchingdon. London Clay, 337 ft.

The place is now supplied from the Purleigh District Waterworks, see p. 82, the public well having been closed for years (1913).

Latton.

Ordnance Map 240, new ser. (Essex 41, SE.). Geologic Map, 47.

In the farm adjoining the clock-tower.

Made and communicated by Mr. G. Ingold. 1875.

Shaft 138 ft., the rest bored. Water-level 123 ft. down.

		Thickness. Ft.	Depth. Ft.
Soil		2	7
Boulder Clay		10	12
[London Clay.]	London Clay	195	202
	[Basement-bed.] Sand and shells	5	212
[Reading Beds, 58 ft.]	Mottled clay	10	222
	Green sand	8	230
	Green sandy loam	15	245
	Dark slate-coloured sandy loam, changing to very hard blue clay	24	269
	Brown clay, 3 ins., and then flints	1	270
Upper] Chalk		95	365

According to Dr. Thresh's Report of 1905, p. 33, the supply depends on shallow wells.

Laver, see **High, Little,** and **Magdalen Laver.**

Lawford.

Ordnance Map 224, new ser. (Essex 19, SE.). Geologic Map 48, NW.

Tendring Hundred Water Co.

Average daily yield (? in 1910) 464,000 gallons.

Well said to be carried $12\frac{1}{2}$ ft. into the Chalk. No further particulars to be got. ?Two or three borings. For an analysis of the water, see p. 412.

According to Dr. Thresh's Reports of 1901, p. 127, and of 1905, p. 76, the hamlet of Wignall Street had a good free supply (from springs) gathered from a hill above and carried in stoneware pipes. The outlying parts were supplied from wells. Then the Tendring Hundred Co. supplied some houses. Its supply has been extended since, along the Colchester Road, etc.

Layer Breton.

Ordnance Maps 241, 223, new ser. Geologic Map 48, SW.

Dr. J. W. Cook's Report for 1900. Repeated in Dr. Thresh's Report of 1901, pp. 134, 135.

Supplied from shallow wells, but some houses without supply. A well on the waste land by the roadside near the Quaker Chapel improved (1899) by sinking large stoneware pipes to below the inlet of the water, which flows from a bed of gravel in the clay, so that enough was got for cottages close by.

Layer de la Haye.

Ordnance Maps 223, 224, 241, new ser. (Essex 36, NE. and SE.). Geologic Map 48, SW.

Dr. J. W. Cook's Report for 1900. Repeated in Dr. Thresh's Report of 1901, p. 135.

Shallow wells were the only supply. At Layer Rows (Rows Farm of the newer map) water was carried from a spring by a brick drain through the farmyard to a well near the back of the house; but there was evidently percolation, as the water in the well was highly coloured and offensive.

According to Dr. Thresh's Report of 1905, p. 70, some concrete-tube-wells had been made recently to supply two groups of cottages.

Layer Marney.

Ordnance Map 241, new ser. (Essex 36, SW.). Geologic Map 48, SW.

1. The Towers. Older Well, near the house. ? 1900.
120 ft. above Ordnance Datum.
Boring made in 1900, and lined with 443 ft. of 5-in. tubes.
Communicated by Mr. T. C. PEACH.
Water-level (Sept., 1900) 103 ft. down.
Yield 180 gallons an hour with pump 160 ft. down (Sept., 1900).
Later water-levels: 1901, 113 ft. down; Oct., 1903, 122 ft.; Feb., 1905, 114 ft.; 28th Oct., 1908, 125 ft. Yield 150 to 160 gallons an hour.

		Thickness. Ft.	Depth. Ft.
Made earth		2	2
[London Clay ?]	Yellow clay	42	44
	Brown clay	6	50
	Blue clay	110	160
	Blue sandy clay	62	222
	Grey sand	11	233
	Mottled sand	9	242
[Reading Beds and Thanet Sand, 84 ft. ?]	Coloured sand and clay	23	265
	Hard green sand	6	271
	Light-blue clay	4	275
	Hard green sand	10	285
	Brown sandy clay	40	325
	Hard sand	1	326
[Upper] Chalk and flints		243	569

Mr. H. W. GOLDING gives the total depth as 578 ft.

It is difficult to separate the London Clay and the Reading Beds. The former may end at 222 ft.

The water is not good and contains 28 grains of sodium-carbonate and 46 of sodium-chloride per gallon. For analysis, see p. 413.

This not being satisfactory, Mr. GOLDING selected a site for a new boring, of which the following is an account, the words in (brackets) being added by Mr. BARROW from specimens.

2. New well and boring. Just off the footpath in the meadow opposite the school. 1909.
Made by Mr. H. C. SMITH. Communicated by Mr. H. W. GOLDING and by Mr. SMITH (down to 345 ft. only, Feb., 1909).
160 ft. above Ordnance Datum.

Mr. SMITH says (22nd Jan., 1909) it is a 6-in. bore line with 6-in. tubes to 300 ft., the bottom 5 ft. perforated and with 50 ft. of 5-in. perforated tubes to 345 ft. Water then came from greensand betwen 296½ and 308½ ft. down.

Water-level 135 ft. down (Mr. SMITH, 130). Yield, been pumped up to 1,000 gallons an hour. Much sand came up, but was diminishing.

		Thickness. Ft.	Depth. Ft.
Dug well (no particulars kept)		—	41
[London Clay.]	London Clay	149	190
	Rock (septaria, calcareous and sandy)	1	191
	Dead sand (dark grey micaceous silty loam)	44	235
	Rock (dark grey septaria)	1½	236½
	Dead sand. [In Smith's account there is a bed ? "rock" 1 ft. thick at 249]. (Very sandy clay, fine)	13½	250
	Live sand (almost all sand, little clay)	10	260
	Pebbles (characteristic little black pebbles)	1	261

Layer Marney, cont.

		Thickness. Ft.	Depth. Ft.
[Reading Beds, 52½ ft.]	Mottled clay (chocolate-colour dominant, some green streaks)	17	278
	Brown sand (bright brown sand) ...	4	282
	Mottled clays (chocolate, some green and blood-coloured). [Coloured sand in Smith's section]	10½	292½
	Green sand (bright green)	9	301½
	Coarser green sand (mixed with some clay)	7	308½
	Light grey sand (light-coloured, faintly green, fine)	5	313½
[Thanet Sand, 50 ft.]	Thanet sand (dark grey micaceous laminated sand)	43½	357
	Brown sand	3	360
	Green sand	3	363
	Flints	½	363½
[Upper and Middle Chalk]	Chalk, dense, with little water ...	85	448½
	Chalk, little water	451½	900

The bottom two beds classed with the London Clay may belong to the Oldhaven Beds.

Charges of dynamite were fired at 750 and 850 ft.

For analysis of the water, see p. 413.

Dr. J. W. Cook's Report for 1900, repeated in Dr. Thresh's Report of 1901, p. 135, says that the parish was not well off for water. At Duke's Farm a very insufficient supply was brought by a pipe from a spring at some distance. Other houses had shallow wells.

Dr. Thresh's Report of 1905, p. 70, notes a well 65 ft. deep at Palmer's Farm.

Lea Bridge (? in Leyton).

Ordnance Map 256, new ser. (Essex 73, NW.). Geologic Map 1, SW., and London District, Sheet 2.

1. East London Waterworks. 1888.

Communicated by W. B. Bryan, Engineer to the Company.

20 ft. above Ordnance Datum.

Shaft 204 ft., the rest bored. With galleries; E. at 190½ to 197 ft. down; W. at 189 to 197 (and higher).

The Chalk very much broken up and with much water in the first 40 ft.

Water found chiefly in the top 30 ft. of the Chalk. Water-level, before pumping, about 30 ft. down. Yield about 3½ million gallons a day.

		Thickness. Ft.	In.	Depth. Ft.	In.
Made ground ...	... ...	6	0	6	0
[? River Drift.]	Red ballast	12	0	18	0
	Bog and peat	2	0	20	0
	Red ballast	5	0	25	0
	Green ballast	4	0	29	0
[Woolwich and Reading Beds, over 17 ft.]	Dark grey sand	8	0	37	0
	Loam and tough sand	0	6	37	6
	Loam sand and pebbles	1	0	38	6
	Hard dark sand and loam, with hard blocks of sandstone	1	8	40	2
	Hard dark sand with sandstone, claystones and thin layers of blue clay ...	4	0	44	2
	Tough dark sand with sand stones and block of congealed pebbles [conglomerate]	2	0	46	2

Lea Bridge, cont.

		Thickness. Ft.	In.	Depth. Ft.	In.
[Thanet Sand, nearly 36 ft.]	Tough dark sand	2	0	48	2
	Grey sand	21	0	69	2
	Very hard sand	7	0	76	2
	Soft green sand	0	6	76	8
	Hard green sand	2	0	78	8
	Soft sand	2	6	81	2
	Flints	0	10	82	0
[All Upper Chalk? 318 ft.]	Chalk, top 5 ft. soft, flints at 87 to 87½	9	3	91	3
	Chalk and flints...	7	0	98	3
	Chalk, 8 in. of flints at the top ...	3	8	101	11
	Chalk and flints	9	0	110	11
	Chalk	2	7	113	6
	Chalk and flints	3	0	116	6
	Chalk, with flints at 119½–120¼, 122¼–123, 126½–126¾, 128¾–129½, 133–133½, 136½–137, 140½–141¾...	27	3	143	9
	Chalk and flints	1	6	145	3
	Chalk, with flints at 147¼–148, 150–150½, 153½–154, 157½–158¼, 161¼–161¾, 164–164 ft. 11 ins.	22	11	168	2
	Flints and chalk, with water	5	0	173	2
	Chalk and a few flints	3	0	176	2
	Chalk, with 10 ins. of flints at top ...	3	10	180	0
	Chalk and flints	4	6	184	6
	Chalk	3	0	187	6
	Chalk and flints	8	0	195	6
	Chalk	2	6	198	0
	Chalk and flints...	6	0	204	0
	Chalk continues (no details ?)... ...	196	0	400	0

2. Sunk for Mr. Cotton. An old well. ? 1853.
From Sir J. Prestwich's MSS. The information from Mr. Taverner, well-sinker.

		Thickness. Ft.	Depth. Ft.
Gravel	... ...	18	18
[London Clay, Reading Beds and Thanet Sand.]	Yellow clay	10	28
	Blue clay	50	78
	White sand	6	84
	Flints in yellow clay	1	85
[Upper] Chalk	... ...	50	135

Leaden Roding.

Ordnance Map 240, new ser. (Essex 42, NE.). Geologic Map 47.
According to Dr. Thresh's Report of 1901, p. 118, there were 46 houses, with nine wells (in or through Boulder Clay).

Leigh, see **Southend.**

Lexden and **Winstree** Rural District, see **Stanway.**

Leyton, Leytonstone, or **Low Leyton,** see also **Lea Bridge.**

Ordnance Map 256, new ser. (Essex 73, NW.). Geologic Map 1, SW., and London District, Sheet 2.

1. Cann Hall (about a mile south of the church).
Information from a workman on the spot.

Gravel, 10 or 12 }
[Clay ?], 18 or 20 } To sand, about 30 ft.

I was also told that a well less than a quarter of a mile northward of Leytonstone Church was 120 ft. deep, all in clay.

Leyton, cont.

Also that a well on the East of Leyton Street, and about three-quarters of a mile west of Leytonstone Church was 150 ft. deep, the top 4 ft. being in gravel, and the rest in clay.

The above three notes were published in 1872.

2. West Ham Union.

Sunk and communicated by Mr. G. Eastell.

		Thickness. Ft.	Depth. Ft.
[River] Gravel	...	16	16
Blue [London] Clay	...	19	35
[Woolwich Beds? 35 ft.]	Brown sand ...	7	42
	Dark sand with water ...	28	70
[Thanet Sand? 40 ft.]	Grey sand with much water ...	36	106
	Loamy sand ...	4	110
[Upper] Chalk, 55 ft.	Chalk: no water ...	40	150
	Chalk and flints: water ...	15	165

For an analysis of the water, see p. 415.

For details of the following Leyton, etc., wells, see the Memoir on London Wells, by G. Barrow, 1912, p. 101.

3. Lea Bridge Road. District Gas Co. 1908.
20 ft. above Ordnance Datum.
Water-level 60 ft. below O.D. Supply 4,000 gallons an hour.

Made ground and River Drift ...	19	250 ft.
Reading Beds [? some London Clay] and Thanet Sand	$84\frac{1}{2}$	
Upper Chalk ...	$146\frac{1}{2}$	

4. Whipscross Road. West Ham Infirmary. 1900.
Water-level 10 ft. below O.D. in 1911. Supply 1,000 gallons an hour.

Well (beds undescribed) and London Clay ...	100	300 ft.
? Oldhaven Beds, Woolwich Beds and Thanet Sand...	130	
Upper Chalk ...	70	

5. A later boring, at the same place. 1903.
About 90 ft. above Ordnance Datum.
Water-level 6 ft. below O.D. Supply 6,000 gallons an hour.

London Clay ...	111	$402\frac{3}{4}$ ft.
Woolwich Beds and Thanet Sand ...	98	
Upper Chalk ...	$193\frac{3}{4}$	

For analysis of the water of one of these, see p. 415.

Lindsell.

Ordnance Map 222, new ser. (Essex 15, SE., 24, NE.). Geologic Map 47.

According to Dr. Thresh's Report of 1901 there were then 60 houses, with 12 private wells.

Bursted [? Bustard] Green. 1873.
Made and communicated by Mr. G. Ingold.

[Glacial Drift.]	Blue clay with chalky rubble ...	9	40 ft.
	White and blue Boulder Clay	29	
	Loamy gravel ...	2	

Liston.

Ordnance Map 206, new ser. (Essex 6, NW.). Geologic Map 47.

Mainly supplied by a well; but several groups of cottages have their own wells.

Little Bardfield.

Ordnance Map 222, new ser. (Essex 15, NW. and SW.). Geologic Map 47.

According to Dr. THRESH's Report of 1901, p. 118, there were then wells at the inn and at the almshouses, from which the inhabitants mainly got water. The farms had their own wells.

Little Bentley.

Ordnance Map 224, new ser. (Essex 29, SW. and NW.).
Geologic Map 48, SW.

According to Dr. THRESH's Report of 1901, p. 125, the supply was from shallow wells. There were some strong springs in the neighbourhood. His Report of 1905, p. 74, adds that one of these springs was used during the manœuvres of 1904, and could supply the village.

Little Braxted, see Great Braxted.

Little Burstead.

Ordnance Map 257, new ser. (Essex 68, SW. and NW.). Geologic Map 1, NE.

According to Dr. THRESH's Report on the Water Supply of Essex, 1901, p. 83, the public pump supplied the school and a few cottages; one farm had a deep well; the other cottages got water from shallow wells and ponds.

The place is now in the area of the Southend Co.'s supply (1913).

Littlebury.

Ordnance Map 205, new ser. (Essex 2, SE., 8, NE.). Geologic Map 47.

1. Dr. Gover's. 1886.
Made and communicated by Mr. INGOLD.
Shaft 39 ft., the rest bored.

Mould	... ...	4	56 ft.
[Drift.]	Clay and Chalk ...	2	
[Chalk.]	Clunch	4	
	Chalk	46	

2. In the middle of the village, where the road to Saffron Walden branches off from the high road. About 157 ft. above Ordnance Datum [? 155]. 1887. Abandoned.

Made and communicated by Mr. G. INGOLD.

		Thickness. Ft.	Depth. Ft.
[River] Gravel	... ...	4	4
[Glacial Drift (? may be partly Post Glacial at top), 214 ft.]	Brown sandy loam	16	20
	Blue sandy loam	10	30
	Brown sandy loam	6	36
	Slate-coloured sandy loam [specimen at 100, pale grey, calcareous]	70	106
	Blue sandy clay...	9	115
	Blue clay, with small chalk stones [specimen at 116, compacted (? clayey) sand, calcareous, with chalk grains]	3	118
	Slate-coloured sand	5	123
	Slate-coloured sandy loam	8	131
	Slate-coloured sand	29	160
	Slate-coloured sandy loam [specimen at 165, pale grey, calcareous]	5	165
	Slate-coloured sand	32	197
	Slate-coloured loam	1	198
	Slate-coloured, very live sand [specimen, at 201, fine grained, compact, calcareous, pale grey]	20	218

The absence of gravel in so great a thickness of Glacial Drift is noteworthy. The same is the case in all but the upper part in the Wenden boring.

This is one of the borings proving a deep channel of Drift in the Valley of the Cam.

Littlebury, cont.

3. For the Saffron Walden Rural District Council? Where the road to Royston branches off from the high road, 125 yds. west of No. 1 and about 8 ft. higher. 164 ft. above Ordnance Datum.

Bored and communicated by Mr. G. INGOLD.

Water-level 10 ft. down. Supply plentiful.

Made ground	3	124 ft.
White Chalk, with a few flints about every 5 ft.	121	

For an analysis of the water, see p. 415.

The Chalk being uncovered by Drift at No. 3, which is 8 ft. higher than No. 2, where Chalk is not reached at 218 ft., it follows that there must be a fall of something more than 226 ft. in the surface of the Chalk between the two borings, a distance of 375 ft., or about 5 in 8. How much greater than this the fall is one cannot say.

According to the Report of the Medical Officer for 1912 (W. ARMISTEAD) there were four public pumps, two in the village, supplied from a deep well (No. 3), the others, at Littlebury Green and Catmore End, from filtered pond-water. There were 13 shallow private wells.

Little Canfield, see **Great Canfield.**

Little Chesterford.

Ordnance Map 205, new ser. (Essex 2, SE., 3, SW.). Geologic Map 47.
Wood Farm, Park Estate, near Chesterford Common. On high ground.
Communicated by M. G. MAYNARD.

		Thickness. Ft.	Depth. Ft.
Red loam ...		5	5
[Glacial Drift.]	Blue Essex [Boulder] clay with stones up to 2 ft. long ...	126	131
	Mixed gravel ...	6	137
[Chalk.]	Blue clunch, hard and dry ...	5	142
	Hard chalk with layers of flint ...	85	227

Depth given as 237 (? mistake).

According to Dr. THRESH's Report of 1905, p. 61, there were no public works, but several private wells, mostly in Chalk.

Little Clacton.

Ordnance Map 224, new ser. (Essex 38, SE. and NE.). Geologic Map 48, SW.

The supply was wholly from very shallow wells, the water coming from a small layer of gravel, in clay, 4 or 5 ft. down. (Dr. THRESH's Report of 1901, p. 126.) The parish is now in the area of the Tendring Hundred Co.

Little Coggeshall.

Ordnance Map 223, new ser. (Essex 26, SW., 35, NW.). Geologic Map 47.
Little Coggeshall Brewery. Mr. Gardner's.
About 95 ft. above Ordnance Datum.
Information from Mr. J. HATLEY.
Water overflowed. 100 gallons an hour.

	Thickness. Ft.	Depth. Ft.
Gravel ...	25	25
London Clay ...	120	145
Slate-coloured sand to green sand ...	60	205
Since deepened :—		
Grey (? the green of above) sand ...	16½	221½
[Upper] Chalk and flints ...	83½	305

Lined from 3 to 228 ft. down with 3-in. tubes.

For analysis of the water (since deepening), see p. 176.

Little Dunmow.

Ordnance Map 222, new ser. (Essex 24, SW.). Geologic Map 47.

Three wells. R. HASLER, *Essex Naturalist*, 1891, vol. v, pp. 216, 217.

1. Cottages (formerly the Flitch of Bacon Inn) about an eighth of a mile west of Throws Farm.

288 ft. above Ordnance Datum. Shaft 140 ft., the rest bored.

[Glacial Drift, about 60 ft.]	[Boulder] Clay	about 55	260 ft.
	Drift [gravel and sand] ...	,, 5	
London Clay, to a thin crust of rock, on piercing which there was a great rush of water ...		,, 200	

2. Mr. Hasler's.

[Boulder Clay.]	White clay ...	20	58 ft.
	Yellow clay ...	about 35	
Drift [? gravel]		3	

3. Jubilee Pump.

[Glacial Drift.]	Half white or chalky clay; half stiff yellow clay. [Boulder Clay]	25	28 ft.
	Drift [? gravel]	3	

Presumably this is the public well, in the centre of the village, that Dr. THRESH says yielded a good supply. Report of 1905, p. 59.

There are several other private wells.

Little Easton.

Ordnance Map 222, new ser. (Essex 23, SE.). Geologic Map 47.

Easton Lodge. 1901.

Made and communicated by Messrs. MERRYWEATHER and SONS.

330 ft. above Ordnance Datum. Water-level 131 ft. down.

Yield tested to about 2,000 gallons an hour, without lowering the level of water 8 ft.

		Thickness. Ft.	Depth. Ft.
Made Ground ...	... ...	1½	1½
[Boulder Clay.]	Hard yellow clay with chalky stones...	19½	21
	Blue clay and chalk pebbles	22	43
[Glacial Gravel and Sand.]	Gravel	7	50
	Yellow sand	3	53
	Live sand	2	55
	Rough sand	5	60
	Ballast	1½	61½
[? London Clay.]	Blue clay	69½	131
	Green shale	2	133
	Loamy clay	6	139
	Grey loam	33	172
[? Reading Beds.]	Mottled clay	18	190
	Green and brown loam...	51	241
[Upper Chalk.]	Chalk and flints	121	362
	Chalk	18	380

For analysis of the water, see p. 416.

According to Dr. THRESH'S Report of 1905, p. 60, there was a private fountain near the post office, supplying a few houses. The rest got water from shallow wells.

Little Hallingbury.

Ordnance Map 240, new ser. (Essex 31, NE.). Geologic Map 47.

1. Just west of the Church.

From observation. W. H. PENNING.

[Glacial Drift.]	Gravel	15	60 ft.
	Boulder Clay	40	
	Grey sand (water) ...	5	

Little Hallingbury, cont.

2. Mr. Ashdown's new house.

200 ft. above Ordnance Datum.

Shaft 82 ft., the rest a 4-in. bore. Casing driven to 148 ft. down.

Water-level ? 60 ft. down.

		Thickness. Ft.	Depth. Ft.
Mould ...		1	1
[Drift.]	White clay	9	10
	Brown boulder-clay	10	20
	Blue clay	14	34
	Brown clay	6	40
	Clean sharp gravel with little water	12	52
[London Clay and Reading Beds.]	Brown clay	3	55
	Black loamy sand	5	60
	Limestone*	1	61
	Black loamy sand	9	70
	Limestone†	2	72
	Black loamy sand	10	82
	Brown clay	6	88
	Black loamy sand	22	110
	Green and red mottled sandy loam	18	128
	Ditto; alternating with thin beds of black sand	$11\frac{1}{2}$	$139\frac{1}{2}$
	Black and green-coated flint pebbles	$\frac{1}{2}$	140
[Upper] Chalk with flints		60	200

* This bed thins off from a thickness of 1 ft. on one side of the shaft, which is 6 ft. in diameter, to 7 in. on the other.

† This bed is less compact than the previous limestone and thins off from 2 ft. on one side of the shaft to 7 in. on the other.

According to Dr. Thresh's Report of 1905, p. 52, the village was supplied from two wells, 10 ft. deep in gravel; isolated cottages from wells about 35 ft. deep, also in gravel.

Little Henny, see **Henny.**

Little Holland.

Ordnance Map 242, new ser., but not marked thereon (Essex, corners of 38, 39, 48). Geologic Map 48, SE.

Formerly supplied wholly from shallow wells (up to 1901). The main of the Tendring Hundred Water Co. now goes through the village.

Little Horkesley.

Ordnance Map 223, new ser. (Essex 18). Geologic Map 48, NW.

Westwood House. 1908.

Made and communicated by Messrs. Duke and Ockenden.

Lined with 6-in. tubes to 292 ft. down. Water-level 128 ft. down.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Clay and flints	11	11
	Gravel	9	20
[London] Clay, with hard rock at $141\frac{1}{2}$ to $142\frac{1}{2}$		145	165
[? Lower London Tertiaries.]	Sand	6	171
	Black clay	14	185
	Sand (with a little water)	$1\frac{1}{2}$	$186\frac{1}{2}$
	Sand and clay	$56\frac{1}{2}$	243
	Bed of flints	2	245
[Upper] Chalk...		159	404

Dr. J. W. Cook's Report for 1900, repeated in Dr. Thresh's Report of 1901, p. 134, says that shallow wells abounded; but some houses were supplied from a good spring.

Little Laver.

Ordnance Map 240, new ser. (Essex 42, SW.). Geologic Maps 1, NW., 47.
Envilles. 1892.
Made and communicated by Mr. G. Ingold.
Shaft; slow spring.

[Glacial Drift.]	Brown Boulder Clay ...	15	20 ft.
	Blue Boulder Clay ...	5	

Little Leighs, see Great Leighs.

Little Maplestead.

Ordnance Map 223, new ser. (Essex 17, NW.). Geologic Map 47.

According to Dr. Thresh's Report of 1901, p. 121, the supply was then unlimited and good: chiefly got from a well (80 ft. deep) with pump. There was another deep well, on private property, and a shallow draw-well.

Dr. Thresh's Report of 1905 notes that there was a public pump over a well about 80 ft. deep (presumably through Boulder Clay to gravel); but most people depended on shallow wells, averaging 15 ft. deep.

Little Oakley, see Great Oakley.

Little Parndon.

Ordnance Map 240, new ser. (Essex 41, NW. and SW.). Geologic Map 47.
Parndon Hall.
Information from Mr. G. Ingold.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift]	Gravel	10	10
	Boulder Clay ...	20	30
	Gravel	12	42
Black [London] Clay	... ...	6	48

Little Saling, see Bardfield Saling.

Little Sampford.

Ordnance Map 222, new ser. (Essex 10, SW., 15, NW.). Geologic Map 47.
The Hall. 1889.
Made and communicated by Mr. G. Ingold (and from specimens sent by him from the boring, in these brackets).
Old well 21 ft., the rest bored. Water-level 56 ft. down.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Sand and gravel	18	18
	Blue Boulder Clay (light-grey, with fragments of chalk)	18	36
[Reading Beds, 25 ft.]	Hard slate-coloured clay (pale-grey and brownish)	16	52
	Reddish-brown clay (brownish-grey red-mottled sandy clay)	5	57
	Green clay (pale, sandy)	4	61
[Thanet Beds, 15 ft.]	Brown clay (fine clayey sand, with a slight pinkish tinge)	13	74
	Dark green clay (sandy)	2	76
[Upper] Chalk	... ...	57	133

This section is of interest as showing two unexpected things:—the presence of a lower bed of Boulder Clay (beneath the Glacial gravel), which does not come to the surface hereabout; and an extension of Reading Beds and Thanet Beds northward, along the valley of the Pant or Blackwater, beyond the limit to which they had been guessed to reach. The brownish sand with a pinkish tint reminds one of the pale pinkish bed above the green base-bed of the Thanet Sand at Sudbury, and proves therefore a westerly extension of that division of the Lower London Tertiaries.

According to Dr. Thresh's Report of 1905, p. 63, there is a public pump, getting water from gravel in the Boulder Clay.

Little Stambridge.

Ordnance Map 258, new ser. (but not marked thereon) (Essex 70, SE.). Geologic Maps 1, NE. and SE.

A fair supply from private shallow wells. Dr. THRESH's Report of 1901, p. 80.

See also under **Stambridge,** p. 266.

Little Thurrock, see also under West Thurrock.

Ordnance Map 271, new ser. (Essex 83, SE.). Geologic Map 1, SE.
Isolation Hospital. Orsett Rural District Council. In Stifford Long Lane.
93 ft. above Ordnance Datum.
Only contains 4½ ft. of water.

Alluvium ... London Clay ... Thanet Sand ...	70	84 ft.
Chalk	14	

For an analysis of the water, see p. 416.
The hospital and the parish are now supplied by the South Essex Co.

Little Wakering.

Ordnance Maps 258, 259, new ser. (Essex 79, NW.). Geologic Map 2.

Almost every house had a well. Water abundant, but its quality questionable. Dr. THRESH, Report of 1901, p. 80.

New England Island. Between Foulness and Havengore Island
Old well. Information from Mr. PURKIS, the sinker, to W. H. DALTON.
Alluvium, composed of sand on the south and clay on the north.
To base of London Clay, about 440 ft.

Little Warley.

Ordnance Map 257, new ser. (Essex 67, SE.). Geologic Map 1, SW
Dr. THRESH's Report on the Water Supply of Essex, 1901, p. 84.
Population about 150 and 1,400 soldiers in barracks, who are supplied by the South Essex Co., as also some houses. Two public pumps and some shallow wells. The public pumps yielded hard water and many people preferred to use the pond, which was liable to pollution.

Little Wigborough.

Ordnance Map 242, new ser. (Essex 46, NE.). Geologic Map 48, SW.
Copt Hall [Marsh]. Old well, about a mile SE. of the Church?
Dr. JAMES MITCHELL's MSS., vol. iv, p. 187.
Yield 80 or 90 gallons a minute.

Brown clay	To Chalk about 300 ft.
Muddy black clay	
Quick sand, with salt water	
Stony gravel	
Blue clay	
Black sand	
Green sand, with water	
30 ft. lower another spring	
20 ,, ,, black sand and green sand ...	

Noticed by Sir J. PRESTWICH, *Proc. Inst. Civ. Eng.*, vol. xxxvii, p. 110, under Mersea Island.

The following information, communicated by J. C. PEACH, probably refers to this well:—

About 10 ft. above Ordnance Datum. Water used to overflow: in May, 1900, it was a few feet down.

For an analysis of the water, see p. 416.

Little Yeldham.

Ordnance Map 206, new ser. (Essex 11, NE.). Geologic Map 47.

According to Dr. THRESH's Report of 1905, p. 64, more than half the population were then supplied from private wells, 15 to 50 ft. deep, and from springs; a few houses depended on brooks; the rest on a public pump.

There are now (1913) two public pumps; one, 35 ft. deep, near Hyde Farm, the other in the village, opposite the school, its water coming from a protected spring.

Longford, see **Langford.**

Loughton.

Ordnance Map 257, new ser. (Essex 57, NE., SE., 58, SW., NW.).
Geologic Maps 1, SW., and London District, Sheet 2.

1. Sir G. Carroll's.

PRESTWICH's *Waterbearing Strata around London*, pp. 67, 235, and Dr. JAMES MITCHELL's MSS., vol. iii, opp. p. 84.

Bored the whole depth.

Water, from the sands above the Chalk, rose to within 90 ft. of the ground.

	Thickness. Ft.	Depth. Ft.
Blue [London] Clay	250	250
Beds of sand	74	324
[Upper] Chalk, no water ...	211	535

Another account (J. SIMPSON, *MS. in Library Inst. Civ. Eng.*) makes the depths to and in the Chalk 445 and 90 ft.

2. Great Eastern Railway Station. 1874-6.

From a drawing, by A. N. LANGLEY, in the Geological Society's Library, from specimens and from information from Mr. LANGLEY.

? over 90 ft. above Ordnance Datum. Shaft 101 ft., the rest bored.

Water [? from Lower Greensand] rose to within 64 ft. of the surface at the rate of about 2,000 gallons a day, May, 1874. On June 14th, 1911 (according to Mr. H. JONES), the water-level was 85½ ft. down, and no pumping had taken place for several years.

		Thickness. Ft.	Depth. Ft.
[London] Clay		167	167
[Reading Beds, 36 ft.]	Sand	26	193
	Clay and stones	10	203
Fine [Thanet] Sand		40	243
Chalk. [At 850 ft. a specimen of chalk with some green grains; at 871 ft. of rather sandy chalk with some green sand]		648½	891½
Chalk, with layers of green sand [? Upper Greensand, except the top few feet. Specimen of green sand, with some chalk (? carried down by boring-tool) at 922 ft.] ...		37	928½
[Gault.] Chalk [? whitish calcareous clay] 4½ ft. [Specimens of Gault clay from 950 ft. down. At the bottom some pieces of phosphatic nodules, such as occur at the base of the Gault]		172 ?	about 1,100

An account from Mr. T. TILLEY, who bored the lowest part of the well, is as follows:—

		Thickness. Ft.	Depth. Ft.
To bottom of grey chalk		894	894
[Upper Greensand, 30 ft.]	Green sand and brown loam	8	902
	Green sand	8	910
	Grey chalk [? calcareous sandstone] ...	4	914
	Green sand	10	924
[Gault.]	Grey chalk [? calcareous whitish clay]	31	955
	Gault (not bottomed)		

This boring, one of the deepest in the London Basin, was the second in Essex that, after passing through the Tertiary Beds, pierced the Chalk, the Upper Greensand, and the Gault, the first being at Harwich.

Low Leyton, see Leyton.

Magdalen Laver.

Ordnance Map 240, new ser. (Essex 41, SE.). Geologic Map 1, NW.

The Bushes. 1870.

Made and communicated by Mr. INGOLD.

16 gallons of water an hour.

Clay ... } 28 ft.
Gravel ... }

According to Dr. THRESH's Report of 1905 the supply depends on shallow wells.

Maldon.

Ordnance Map 241 (Essex 54, NW.). Geologic Map 1, NE.

Writing of this town in 1860, in the Second Report of the Medical Officer of the Privy Council, p. 167, Dr. GREENHOW says, 'The water is of good quality, hard but pure, and is obtained from springs and artesian wells.'

1. Messrs. GRAY and SONS. 1891.

Made and communicated by Messrs. ISLER and Co.

Lined with 230 ft. of $7\frac{1}{4}$-in. tubes from 4 ft. down and with 70 ft. of 6-in. tubes from 161 ft. down.

Water-level 124 ft. down.

		Thickness. Ft.	Depth. Ft.
Dug well (the rest bored)		—	152
[London Clay.]	Blue clay (claystone at bottom)	74	226
	Fossil	3	229
	Blue clay	7	236
[Oldhaven Beds.]	Loamy sand	7	243
	Grey sand and shell	1	244
	Grey sand	4	248
	Black pebbles (with clay at the bottom)	2	250
[Woolwich Beds.]	Loamy sand	11	261
	Mottled clay	2	263
	Green loamy sand	4	267

2. Messrs. Warren's Foundry, near the railway-station.

Information from Mr. HATLEY, well-sinker, to W. H. DALTON.

Gravel ... ... 21 } To sand, 151 ft.
London Clay ... 130 }

3, 4. Northey, an island below (or eastward of) the town, and South House, about a mile south-east of the town.

Old wells. Information from Mr. HATLEY, the sinker, to W. H. DALTON.

Water overflowed.

To base of London Clay, 250 ft.

5. Workhouse. New well. (? 1909.)

Information from Mr. ALMOND, Surveyor, Maldon Rural District Council.

118 ft. above Ordnance Datum.

Lined to 325 ft.

Yield 800 gallons an hour with pump-barrel 200 ft. down.

Water turbid with fine sand.

Maldon, cont.

		Thickness. Ft.	Depth. Ft.
Soil	...	1	1
[Drift.]	Rough gravel ...	19	20
	Coarse sand and fine ground ? ...	7	27
[London Clay.]	London Clay ...	73	100
	Hard grey sand ...	½	100½
	Grey sand ...	1½	102
	Hard grey stone ...	½	102½
	Grey sand ...	77½	180
	Blue clay ...	32	212
	Silty loam ...	22	234
	Dark stone ...	1	235
	Silty loam ...	5	240
[Oldhaven Beds.]	Fine grey sand with water ...	19	259
[Woolwich Beds and Thanet Beds ?.]	Red mottled clay ...	11	270
	Green ,, ,, ...	13	283
	Black silty clay ...	23	306
	Fine compact sand ...	34	340

For an analysis of the water, see p. 418.

6. Waterworks. Spital Road. 1870. Boiler-house well.
Information from W. H. Penning (and later from Mr. Beaumont in these brackets).
(115·2 ft. above Ordnance Datum.)
Shaft throughout (5 ft. diameter). (Water-level 150 ft. down, Aug., 1908.)

Yield 5,000 gallons an hour ? originally. In Dec., 1898, Mr. Strachan found it to be 54,000 gallons a day and estimated the minimum [? for continuous pumping] at 40,000 to 42,000.

London Clay, 234 ft.

(Total depth a little more than 234, the well ending in sand and loam not much below the London Clay.)

For analyses of the water, see p. 417.

7. Spital Road Waterworks Engine-house well. 1911.
Shaft, of 6 ft. diameter, 200 ft., the rest bored.
Made and communicated by R. Richards and Co.
Water-level 160 ft. down.
Yield, 180 gallons an hour with pump 420 ft. deep, after intervals of 2 hours.

		Thickness. Ft.	Depth. Ft.
Dug well (old)	...	—	194
[London Clay]	Hard clay ...	12	206
[? Oldhaven Beds and Woolwich Beds.]	Sand with some hard bands ...	46	252
[Woolwich Beds]	Brown clay ...	4	256
	Very hard stone (dark red) ...	1	257
	Clay ...	9	266
	Green sand ...	16	282
	Brown clay and sand ...	5	287
[Thanet Sand.]	Sand ...	61	348
	Bed of flints ...	2	350
[Upper Chalk.]	Chalk and flints...	266	616
	Hard grey chalk ...	18	634

The result of the deep boring was a marked increase of the chlorides in the water.

8. Waterworks. Wantz Road, in the centre of the town.
57½ ft. above Ordnance Datum.

Mr. John French, from particulars given by Mr. J. Furlong, the well-sinker, who showed him specimens from the bore, with some further information.

Maldon, cont.

Well 58 ft., the rest bored.

Water rose to 42 ft. below the surface originally, to 50 ft. in 1908.

		Thickness. Ft.	Depth. Ft.
Soil	...	1	1
London Clay	...	168	169
[Oldhaven Beds.]	Sand ...	13	182
	Black [flint] pebbles ...	$\frac{3}{4}$	$182\frac{3}{4}$
[Reading Beds.]	Mottled clay ...	3	$185\frac{3}{4}$
	Red clay ...	2	$187\frac{3}{4}$
	Bright green sand ...	14	$201\frac{3}{4}$
	Dark sandy clay ...	30	$231\frac{3}{4}$
[?Thanet Beds.]	Sand ...	30	$261\frac{3}{4}$
	Dark clay ...	2	$263\frac{3}{4}$

Another account gives the depth to the base of the London Clay as 186 ft., and the total depth as 279, and differs somewhat in details.

According to the Medical Officer's Report for 1912 the well is an old one, made to supply a flour-mill. The well was deepened to 156 ft., with a new boring to 290, and the result was an increase of supply from 25,000 to 100,000 gallons a day. The water was under suspicion in 1900, as it was getting harder: the upper part of the brickwork was found to be letting in water (?polluted). See Analyses, p. 417.

The following information from the Water Works Directory, 1911, p. 226:—The works were established in 1862. The area supplied is the borough of Maldon only, and its population is 5,600. The yearly supply is 50,000,000 gallons, the daily consumption per head, for all purposes, being 20 gallons. There are two wells and borings to the sand of the Reading Beds and one to the Thanet Sand.

Surface-wells and springs, liable to pollution, are still used by some people (1912).

Manningtree.

Ordnance Map 224, new ser. (Essex 20, SW). Geologic Map 48, NW.

Shallow wells used to be the sole supply; but the Tendring Hundred Water Co. now supply many houses (1913).

Stour Brewery (Messrs. Alston). 1888.

Boring made and communicated by Messrs. Z Hills & Co.

Water-level 11 ft. down. Good supply.

		Thickness. Ft.	Depth. Ft.
Made ground and gravel	...	4	4
[? River Drift.]	Clay, light-coloured with dark veins ...	4	8
	Coarse sand ...	2	10
	Sandy gravel ...	6	16
	Fine dark sand ...	9	25
[London Clay, 17 ft.]	Yellow clay ...	3	28
	Yellow clay, darker and sandy ...	5	33
	Brown sandy clay ...	9	42
[Reading Beds, 38 ft.]	Green mottled sandy clay ...	3	45
	Dark ,, ,, ,, ...	1	46
	Brown ,, ,, ,, ...	2	48
	Blue clay ...	2	50
	Green sandy clay ...	17	67
	Dark clay ...	7	74
	Loamy green sand ...	6	80
[Upper] Chalk	...	40	120

Manuden.

Ordnance Map 222, new ser. (Essex 13, SW., SE., 22, NW., NE.).
Geologic Map 47.

1. House opposite the Vicarage. 1887.
Made and communicated by Mr. G. Ingold.
Bored throughout.
Water-level 18 ft. down. Slow spring.

		Thickness. Ft.	Depth. Ft.
[Glacial] Drift.	Gravel: a loose drift ...	35	35
	Light-blue clay	$10\frac{1}{2}$	$45\frac{1}{2}$
	Light-brown clay ...	$3\frac{1}{2}$	49
[Upper] Chalk		89	138

This shows the occurrence of Drift clay beneath the Glacial gravel here, which would not be inferred from the Geological Survey Map (Sheet 47), or else of Eocene clay.

2. Mallows Green. 1901.
Made and communicated by Mr. H. G. Featherby.
319·35 ft. above Ordnance Datum.
Rest water-level 99 ft. down (March, 1901).
Shaft 4 ft. 3 in. diameter to 40 ft. down, then 3 ft. 6 in. to 50 ft. down, and 4 ft. 3 in. again to 105 ft. down; the rest a 4-in. bore-hole.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Brown clay	3	3
	White clay	10	13
	Chalk and blue clay with water	3	16
	Blue clay with many flints ...	26	42
	Gravel	3	45
	Loamy sand	4	49
	Brown clay	1	50
[Upper] Chalk with flints		105	155

3. Mr. Burl's Grocery Stores.
Communicated by Mr. Featherby.

Water at 16 ft., October, 1900. Gravel and loam, 24 ft.

For an analysis of a water from a well said to be 200 ft. deep, see p. 418.

According to Dr. Thresh's Report of 1905, p. 52, the village was very fairly supplied from wells 15 to 25 ft. deep. Some cottages at Upend had to go half a mile to the farm for water.

Maplestead, see Great and Little Maplestead.

Margaret Roding.

Ordnance Map 240, new ser. (Essex 42, NE. and SE.). Geologic Map 47.

According to Dr. Thresh's Report of 1901, 10 shallow wells (presumably in Boulder Clay) supplied 60 houses.

Margaretting.

Ordnance Map 240, new ser. (Essex 52, SW., 60, NW.). Geologic Map 1, NE.
1. Eweland Hall (western end of village). 1901.
Made and communicated by Messrs. Isler and Co.
Lined with 435 ft. of tubes, of 4-in. diameter, from a foot down.
Water-level 122 ft. down.

		Thickness. Ft.	Depth. Ft.
Well (? old; the rest bored)		—	22
[London Clay.]	Blue clay	26	48
	Sandy clay	57	105
	Blue clay and stone ...	9	114
	Sandy clay	323	437
[?Oldhaven Beds.]	Grey sand	113	448
	Sand and pebbles ...		451

For an analysis of the water, see p. 419.

Margaretting, cont.

2. On the main road, near the pond in the village.
Information from Mr. Straight.

Said to be a dug well 214 ft. deep, deriving water from sands beneath the London Clay. Rest-level of water 30 ft. down. For analysis, see p. 419.

3, 4. Two old wells.
Information from Mr. Rolfe, the sinker, to W. H. Dalton.
Ivory Hill, or Ivy Hill, Cottage.

Brickearth ...	18	26 ft.
Gravel ...	8	

Coptfold Hall.
Sandy loan, to sand and gravel ... 27 ft.

5. "At Margaretting Tye trial borings revealed the presence of water at an easily accessible depth. Upon analysis it was found suitable for domestic purposes." Dr. Thresh Report, Chelmsford Rural Sanitary Authority, for 1893.

According to Dr. Thresh's Report on the Water Supply of Essex, 1901, p. 103. There were two public pumps, one giving good water, but limited in quantity, the other yielding very hard water. One deep well yielded an Epsom Salts water.

Markshall.

Ordnance Map 223, new ser. (Essex 26, NW.). Geologic Map 47.
Mark's Hall Estate. Trial-boring for water. 1899. Near the boundary of the Park.
Made and communicated by Mr. F. Bennett, of Ipswich.
Water-level 28 ft. down.

		Thickness. Ft.	Depth. Ft.
[Drift.]	Yellow clay ...	16	16
	Loam	2	18
	Loamy sand ...	6	24
	Red gravel ...	4	28
	Ballast	$2\frac{1}{2}$	$30\frac{1}{2}$

Mashbury.

Ordnance Map 240, new ser. (Essex 43, NW.). Geologic Map 47.
No village. One public pump giving fairly good water. Many houses supplied from a brook. Dr. Thresh's Report of 1901, p. 103.

Matching.

Ordnance Map 240, new ser. (Essex 41, NE., 42, NW.). Geologic Map 47.
Two wells. Made and communicated by Mr. Ingold.

1. The School.
Drift gravel and clay ... $30\frac{1}{2}$ ft.

2. Newman's End. 1898.

Soil ...	... ...	2	20 ft.
[Boulder Clay.]	White clay ...	8	
	Brown clay ...	3	
	Blue clay ...	7	

According to Dr. Thresh's Report of 1905, p. 33, there were two or more public wells (? including the above); but most of the supply came from private wells.

Mayland.

Ordnance Map 241, new ser. (Essex 62, NE., 63, NW.). Geologic Map 2.

1. Nipecil's Farm, see Analyses, p. 419.

2. Mill. An old well.
Information from Mr. Hatley, the sinker, to W. H. Dalton.
Through London Clay, to sand, 300 ft.

According to Dr. Thresh's Report on the Water Supply of Essex, 1901,

Mayland, cont.

p. 110, there was practically no village and no public supply. In most cases rain-water was got, from roofs and from ponds. A few cottages got water from a pump in Althorne. One or two farms had bored wells.

Since then Mr. Fels has established a farm-colony and bored a deep well, but the bulk of the population is supplied from the Purleigh works (see p. 82).

According to Dr. Thresh's Report of 1905, p. 40, in the bored wells the water-level was falling and the yield decreasing.

Mersea.

Ordnance Map 242, new ser. (Essex 46, NE., 47, NW., NE.).
Geologic Map 48, SW.

According to the *Essex County Standard*, 25 April, 1908, "Until the last month or two all the drinking water used on the island was drawn from surface wells or from springs issuing from the base of the cliff along the west side. A large proportion of the houses have their own wells, which generally yield an ample supply."

See also **East Mersea** and **West Mersea.**

Messing.

Ordnance Maps 223, 241, new ser. (Essex 35, NE., SE.)
Geologic Maps 47, 48, SW.
Supply for Tolleshunt Knights.

A well 28 ft. deep was sunk near where some springs rose (from gravel) and the spring-water was tapped underground. The water rose to within 3 ft. of the surface. A second well, 12 ft. deep, has been sunk nearer the springs, and the water is 3 ft. down. Yield from 20,000 to 30,000 gallons a day.

There are also several shallow wells.

See also p. 80, and under **Tiptree,** p. 281.

Metropolitan Water Board.

Though the supply is chiefly from the Lea, that is supplemented from wells at the following places in Essex—Chingford (p. 119), East Ham (really in Barking, p. 90), Leyton (pp. 209, 210), Waltham Holy Cross (Waltham Abbey, pp. 289, 290), Walthamstow (pp. 292, 293), and Wanstead (p. 295).

Mile End, see **Colchester,** p. 128.

Mistley.

Ordnance Map 224, new ser. (Essex 20, SW.). Geologic Map 48, NW.

1. Messrs. Edme and Co., Malt Extract Manufacturers (about 20 ft. from Messrs. Free's well).

Made and communicated by Mr. F. Bennett, of Ipswich.
Tubes of $7\frac{1}{2}$ in. internal diameter driven to a depth of 129 ft.

		Thickness. Ft.	In.	Depth Ft.	In
Old well (the rest bored)		—		40	6
[Reading Beds.]	Stiff mottled clay	15	6	56	0
	Mottled loam	3	0	59	0
	Running sand, with 4 ins. of rock at the bottom	3	4	62	4
	Stiff green loam	9	0	71	4
	Green clay	3	0	74	4
	Coarse grey sand	1	0	75	4
	Green clay	2	0	77	4
	Coarse grey sand	2	8	80	0
	Green clay	6	6	86	6
	Blue silty clay	7	0	93	6
	Brown clay	4	3	97	9
	Green loam	2	9	100	6
	Green-coated flints and chalk	1	6	102	0
[Upper] Chalk. Layer of flints at 238, and great many flints from 256 to 301		199	0	301	0

Mistley, cont.

2. Messrs. Free, Rodwell and Co.'s Malting. 1883. Boring.
Communicated by Mr. P. BRUFF from information from the sinker, Mr. F. BENNETT.

About 37 ft. above Ordnance Datum.
Tubes driven about 10 ft. into the Chalk.

Water rose to $32\frac{1}{2}$ ft. below the surface after flint bed at top of the Chalk was penetrated (14 in. higher at high tide). Supply abundant (over 6,000 gallons an hour), and quality good. At a later date said to be 4,500 gallons an hour for 16 hours a day.

		Thickness. Ft.	Depth. Ft.
Made ground		$2\frac{3}{4}$	$2\frac{3}{4}$
Mould		$\frac{3}{4}$	$3\frac{1}{2}$
Gravel		4	$7\frac{1}{2}$
[London Clay, $36\frac{1}{4}$ ft.]	Brown clay, with 15 in. rock (septaria) 2 ft. above the bottom	$15\frac{3}{4}$	$23\frac{1}{4}$
	Dark sandy loam	2	$25\frac{1}{4}$
	Clay	$10\frac{1}{4}$	$35\frac{1}{2}$
	Fine light-coloured sand (water) [?basement-bed]	$8\frac{1}{4}$	$43\frac{3}{4}$
[Reading Beds, 58 ft.]	Mottled clay	$16\frac{3}{4}$	$60\frac{1}{2}$
	Fine light-coloured sand (water)	$3\frac{1}{2}$	64
	Green loamy sand	10	74
	Mottled clay	2	76
	Coarse grey sand	$\frac{1}{2}$	$76\frac{1}{2}$
	Green clay	1	$77\frac{1}{2}$
	Coarse grey sand	$2\frac{1}{2}$	80
	Green clay	7	87
	Blue silty clay, bottom foot brown	12	99
	Streaky loam, top 9 ins. dark, the rest grey	$2\frac{1}{4}$	$101\frac{1}{4}$
	Green-coated flints	$\frac{1}{2}$	$101\frac{3}{4}$
[Upper] Chalk; at first rather soft, then in small cuboidal pieces, with much water; few flints met with		$130\frac{1}{4}$	232

3. Messrs. Free, Rodwell and Co.'s. Malting. 1891.
Made and communicated by Mr. F. BENNETT.
39 ft. above Ordnance Datum.
Boring, tubed to $95\frac{1}{2}$ ft. down.
On a level with the quay, which is about 30 yds. off.
Water-level sinks 20 in. at low tide.

The steam-pump was throwing considerably over 6,500 gallons an hour, and although we pumped for several hours, the supply seemed to be abundant. The water drops about 2 ft., and then remains at a fixed level of 14 ft. 4 in. from the surface. (Letter from Messrs. FREE and RODWELL, November, 1891.) $32\frac{1}{2}$ ft. down later.

		Thickness. Ft.	Depth. Ft.
Made soil		4	4
[London Clay, $17\frac{1}{2}$ ft.]	Light-coloured mottled clay	10	14
	Brown mottled clay	5	19
	Running sand [? basement-bed]	$2\frac{1}{2}$	$21\frac{1}{2}$
[Reading Beds, 59 ft.]	Mottled clay	17	$38\frac{1}{2}$
	Running sand	$1\frac{1}{2}$	40
	Mottled loam	$11\frac{1}{2}$	$51\frac{1}{2}$
	Green mottled clay	$4\frac{1}{2}$	56
	Green sandy loam	$1\frac{1}{2}$	$57\frac{1}{2}$
	Rough sand	$\frac{1}{2}$	58
	Green sandy loam	1	59
	Running sand	$1\frac{1}{2}$	$60\frac{1}{2}$
	Stiff blue clay	$15\frac{1}{2}$	76
	Brown clay	$1\frac{1}{2}$	$77\frac{1}{2}$
	Green loam	2	$79\frac{1}{2}$
	Flint-bed	1	$80\frac{1}{2}$
[Upper] Chalk.	Large flint $82\frac{1}{2}$ ft. from surface	80	$160\frac{1}{2}$

For an analysis of the water of one or both of these wells, see p. 420.
No. 1 also belongs to the same firm.

Mistley, cont.

4. Tendring Hundred Waterworks. North of the railway. Two bore-holes. Average daily yield 50,000 gallons a day.

To Chalk ...	110	about 130 ft.
In Chalk ...	about 20	

A communication from the Admiralty says that the shaft is 50 ft. deep, that iron tubes were carried down into the Chalk, and that the depth is 300 ft.

The average daily yield of these wells (in 1912) was 53,000 gallons.

For analyses of the waters from both wells, see p. 420.

According to Dr. THRESH's Report of 1901, pp. 127 and xv., the old village had a good free supply for many years, the gift of Mr. RIGBY, of Mistley Hall, but which did not supply that house. This was extended to many houses in New or Upper Mistley. (The water comes from springs on the side of Furze Hill.)

The Tendring Hundred Co. now supply the whole place. (1913.)

Moreton.

Ordnance Map 240, new ser. (Essex 51, NW.). Geologic Map 1, NW.

In 1905, largely supplied from a public well or wells. Later information (1913) says that all private wells are fitted with pumps. The wells are shallow and yield an ample supply. They must be in Glacial gravel.

Moulsham, see Chelmsford.

Mountnessing.

Ordnance Map 257, new ser. (Essex 59, SE., 60, SW.). Geologic Map 1, NE.

Tylhus. East of Bacons, about a mile northward of Mountnessing Hall. 1895.

Under 300 ft. above Ordnance Datum.

A boring.

		ft.	in.
[Glacial Drift.]	Heavy [Boulder] Clay	5	6
	Sand [specimen coarse, brown, with small stones]	0	4
[? London] Clay		—	

One sample of the water contained 294 grains of chlorine to the gallon, another 301.

Another well about 20 yds. away yielded a normal gravel-water (13 grains per gallon of chlorine); but no water was found until a depth of 28 ft. was reached, whereas in the Tylhus well it was found in the sand $5\frac{1}{2}$ ft. down. The Tylhus well is on a hill and many miles from the sea or a tidal river.

According to Dr. THRESH's Report on the Water Supply of Essex, 1901, p. 84, the population was about 930; shallow wells and a spring gave the sole supply; the quantity seemed sufficient, but the quality was questionable.

The South Essex Co.'s mains are being extended to supply the village.

Mucking.

Ordnance Maps 257, 271, new ser. (Essex 84, NW., NE.). Geologic Map 1, SE.

Formerly the water was derived from shallow wells (Dr. THRESH's Report of 1901, p. 70). In 1905, 25 per cent. of the houses were supplied from private wells, from 20 to 70 ft. deep.

1. Waterworks. Mucking Ford, more than a mile south-south-west of the village. West of the road and just north of the stream. On the Linford Estate. 1885.

Communicated by Mr. W. RUSS.

18 ft. above Ordnance Datum.

Bore of 9 in. diameter. Water (apparently wholly from the Chalk) rose to 14 ft. above the surface, and still did so in 1888. The flow at the surface

Mucking, cont.

was 90 gallons a minute, which has increased to 110. Pumping at the rate of 150 gallons a minute lowered the water in the bore-hole to about 12 ft. down.

		Thickness. Ft.	Depth. Ft.
[? Alluvial.]	Black mould	2	2
	Blue clay	1	3
[River Drift.]	Running gravel	3	6
[Thanet Beds, 45 ft.]	Light-coloured sand	11	17
	Dark sandy clay [? clayey sand], dry...	33	50
	Flints	1	51
[Upper] Chalk, with flints at 54 ft. (6 ins.) and at 58 ft. (3 ins.), most of the water coming from beneath this lower bed		16	67

According to Messrs. TILLEY, who made the well, the depth to the Chalk was $51\frac{1}{2}$, and the water overflowed, at the rate of about 30 gallons a minute, at 15 ft. above the ground.

2. A later work at the same place, then called Linford Estate Waterworks. Two borings. 1900.

Made and communicated by Messrs. TILLEY.

Beds as in the older section. Merely a difference in thickness.

Surface water-level 3 ft. down. Chalk-water overflows.

		Thickness. Ft.	Depth. Ft.
The same as the older section (Alluvium and gravel) ...		—	6
[Thanet Beds, 44 ft.]	Light-coloured sand	18	24
	Dark sandy clay	25	49
	Green flints	1	50
[Upper] Chalk and flints		30	80

On April 2nd, 1900, the water was 14 ft. down, after pumping for 7 hours, at the rate of about 130 gallons a minute. On ceasing pumping the water rose in the pipe in 20 seconds, and overflowed into the well, and then continued rising to the overflow-pipe, about 18 in. up.

The works have been taken over by the South Essex Water Co.

The average daily quantity pumped in 1910 was 832,515 gallons.

For analyses of the water, see p. 421.

3. Gobions Farm. $1\frac{1}{2}$ miles southward of Mucking Church. 1913.

Made and communicated by Messrs. LE GRAND and SUTCLIFF.

Water-level 9 ft. down (1913).

		Thickness. Ft.	Depth. Ft.
[River Drift]	Loam	1	1
	Sandy clay	3	4
	Sand	1	5
	Sandy clay	4	9
	Gravel with water	16	25
	Thanet Sand	68	93
	Flints	2	95
[Upper Chalk]	Chalk and flints	171	266
	,, ,, ,, (sticky) ...	$10\frac{1}{2}$	$276\frac{1}{2}$
	,, ,, ,, (hard) ...	$6\frac{1}{2}$	283

Mundon.

Ordnance Map 241, new ser. (Essex 64, SE.). Geologic Map 1, NE.

1. Mundon Hill. For the Maldon Rural District Council. On the eastern side of the main road, north of Sparrow Wick cottages. 1909.

Made and communicated by Messrs. CHEELD and Co. With some particulars from the Local Government Board. Specimens examined by G. BARROW.

Mundon, contd.

40 ft. above Ordnance Datum. Shaft 319 ft. (? more).
Rest-level of water 49 ft. down; after pumping, 26 ft. lower.
Yield 1,000 gallons an hour. For an analysis of the water, see p. 422.

		Thickness. Ft.	In.	Depth. Ft.	In.
[London Clay.] Carried too far down?	Top soil and brownish yellow clay ...	35	0	35	0
	London Clay	197	0	232	0
	Brown sandy clay	12	10	244	10
	Sandstone	0	6	245	4
	Brown clay, with shell	9	0	254	4
	Shell and sand (water came in) ...	1	2	255	6
	Sand	8	6	264	0
	Dark clay	11	0	275	0
[Reading Beds and Thanet Beds.]	Red mottled clay (specimens sandy)	7	0	282	0
	Clayey green (light-coloured) sand and green sand	24	0	306	0
	Dark sandy clay	25	0	331	0
	Coarse clayey sand	11	0	342	0
	Fine clayey sand	6	0	348	0
	Dark sandy clay	32	6	380	6
	Green flints	0	4	380	10
[Upper] Chalk	... ...	3	2	384	0

2. Brickhouse Farm. Near a tidal creek. 1910.
Communicated by J. S. SURRIDGE.

16 ft. above Ordnance Datum. Well 10 ft., the rest bored, 5-in. diameter to 230 ft., then 4 in. Water-level 13 ft. down (1910). Pumping 60 gallons an hour lowered water to 48 ft., 200 gallons to 84, 500 gallons to 96. Yield about 600 gallons an hour with pump 96 ft. down (1910).

		Thickness. Ft.	Depth. Ft.
London Clay, top 30 ft. brown, the rest blue ...		156	156
[Oldhaven Beds, 14 ft.]	Grey sand and shells	$1\frac{1}{2}$	$157\frac{1}{2}$
	Sandstone	$2\frac{1}{2}$	160
	Grey sand	5	165
	Pebbles	2	167
	Grey sand and shells	3	170
[Woolwich Beds and Thanet Beds.]	Coloured sands	32	202
	Grey sand, with green at 217 to 218	25	227
	Grey sand, top foot running sand	41	268
	Green sand	1	269
	Flints	1	270
[Upper] Chalk and flints		55	325

3. Mundon Hall. Old well, about 300 ft. deep. Formerly supplied most of the parish, water being carried a considerable distance.
For analysis of the water, see p. 422.

4, 5. Old wells.
Information from Mr. HATLEY, the sinker, to W. H. DALTON.
Shepherd's Inn. To base of London Clay, 250 ft. Water overflowed.
Vicarage. To base of London Clay, 270 ft.

Navestock.

Ordnance Map 257, new ser. (Essex 58, SE., 59, SW.). Geologic Map 1, NW.
Tan House Farm. Communicated by H. G. FEATHERBY.

Brown clay ...	9	33 ft.
London Clay ...	24	

There are (1913) two shallow public wells, one at Sabine's Green, the other near the Alma Arms.

Nazeing or Nasing.

Ordnance Maps 239, 240, new ser. (Essex 49, NE. and NW.).
Geologic Map 1, NW.

1. Nazeing Park. 1792.
Communicated by Lieut.-Col. G. PALMER.

		Thickness. Ft.	In.	Depth. Ft.	In.
[London Clay, 196 ft.]	Yellow clay, passing down into the next / Blue clay, passing down into the next / Sandy clay.	194	0	194	0
	[Basement-bed ?] Shell-rock	1	6	195	6
	[Basement-bed ?] Gravel-rock	0	8	196	2
[Reading Beds.]	Red clay ... ... about	20	0	216	2
	Red sand ... ... about	0	8	216	10

The original memorandum from which the above was taken adds that 194 ft. were sunk and 34 ft. bored, making a total of 228 ft. or 11 more than above given. Perhaps therefore the London Clay should be given as 207 ft. thick.

2. For the proposed South Essex Water Board. ½ mile north of St. Leonard's. 1900.
Made and communicated by H. G. FEATHERBY. Also from H. ROFE.
Trial-bore, 6 in., 5 in., and 4 in. in diameter.
150·68 ft. above Ordnance Datum.
Water-level 7 April, 1900, 52 ft. down; 17 April, 1900, 71½; 24 April, 1900, 69½.

		Thickness. Ft.	Depth. Ft.
Mould	... ...	1	1
[London Clay, 86½ ft.]	Stiff brown clay...	29	30
	Stiff blue clay (a little surface-water only)	44	74
	Blue clay with fine sand (water at 71 ft. down)	12	86
	Slate-coloured shaly clay	1½	87½
[Reading Beds, 50½ ft.]	Green and red mottled red clay ...	2½	90
	Very fine white sand (water at 86 ft.) ...	3	93
	Green and red mottled loam	2	95
	Green and red sand	1	96
	Green and red clay	3	99
	Mixed gravel (water at 93 ft.)... ...	1	100
	Very fine sharp white sand (water at 95 ft.)	9	109
	Grey and green sand with clay ...	2	111
	Grey sand	4	115
	Slate-coloured shaly clay	1½	116½
	Slate-coloured sand with a little clay ...	2	118½
	Rounded black flints in brown clay ...	1	119½
	Heavy black sand	18	137½
	Green-coated flints	½	138
[Upper Chalk.]	Chalk-rubble	2	140
	Chalk	7	147

For an analysis of the water, see p. 422.

3. Belchers. Just northward of Nazeing Gate.
Bore-hole 180 ft. to pebbles and green sand [? basement-bed of London Clay] clogged by sand.

4. Nazeingbury.
A little below the 100 ft. contour.
Well about 28 ft., and boring about 82. Water rose to 24 ft. from the surface. Pebbles and green sand touched near the bottom [? basement-bed of London Clay].

Nazeing, cont.

5. St. Leonard's, nearly ¼ mile west-north-west of the house.
A little under 200 ft. above Ordnance Datum.
Water-level 70 (?) ft. down (1900), gradually falling.
Yield, sufficient for the house.
Said to be sunk through the London Clay to the Chalk (100 ft.).
For analysis of the water, see p. 422.

According to Dr. THRESH's Report of 1905, p. 33, there were then public wells, but some parts had a difficulty in getting water.
Now supplied by the Herts and Essex Co.

Netherhall, see Roydon.

Nevendon.

Ordnance Map 258, new ser. (Essex 69, SW., 68, SE.). Geologic Map 1, SE.
Dr. THRESH's Report on the Water Supply of Essex, 1901, p. 84.
Population about 160. There were two private shallow wells, serving a few neighbouring cottages. Most of the houses were supplied from ponds.
Now in the area of the Southend Co., whose Nevendon pumping station is in the parish of Pitsea (see p. 238).
There is said to be a deep well at the Hall.

Newport.

Ordnance Map 222, new ser. (Essex 8, SE., 9, SW.). Geologic Map 47.

1. Grammar School. 1887. On or just west of the site of 'Castle,' and about 1,000 ft. a little west of north from the church.
Over 200 ft. above Ordnance Datum.
Made and communicated by Mr. G. INGOLD.
A boring, with a pipe, of 4 in. internal diameter, below the old well.
Abandoned.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Old well, through gravel and sand ...	—	26
	Grey (slate-coloured) sandy loam [specimen, at 127, pale fine clayey sand, calcareous]	109	135
	Grey (slate-coloured) sandy loam, more sandy, with fine chalk [specimen, at 178, pale grey compact calcareous sand]	53	188
	Slate-coloured clay	2	190
	Dark grey sandy loam [specimen, at 212, pale grey, calcareous]	27	217
	Dark grey sandy loam, more sandy than the above, with occasional layers of loam	67	284
	Hard clay	1	285
	Sand, with small flints and chalk-stones	3	288
	Sandy loam	15	303
	Chalk-stones and flints	1	304
	Clay, with a few stones	13	317
	Stones, mostly flints, in clay	13	330
	Chalk [? a boulder]	5	335
	Live sand, which rose 25 ft. up the bore, and prevented the tube being driven further	5	340

The base of the Drift therefore was not reached at this great depth, the greatest in the deep channel of Drift in the valley of the Cam.

Newport, cont.

2. Newport House. 1898.
200 ft. above Ordnance Datum.
Bored and communicated by Mr. Ingold. With some information from Major Barthropp.
Water-level about 20 to 25 ft. down (1912). Yield has never failed (1912).

		Thickness. Ft.	Depth. Ft.
Soil	...	1	1
Glacial [Drift.]	Brown loam	3	4
	Gravel	8	12
	Blue clay, with stones	12	24
	Gravel, with water	21	45
	Hard blue clay	17	62
	Clay and stones	4	66
	Blue clay	39	105
	Live sand	2	107
	Hard blue clay and stones	7	114
	Sandy clay	20	134
	Live sand	4	138
	Blue clay	47	185
Chalk.	Chalk	41	226
	Very hard chalk	5	231
	Chalk	41	272

This boring is clearly in the deep Drift channel.
For analysis of the water, see p. 423.

3. Newport Lodge. See Analyses, p. 423.

4. Public Well. Near the end of Station Road and back road to Wicken. 1897.
? 195 ft. above Ordnance Datum.
Bored and communicated by Mr. G. Ingold.
Water rose to within a foot of the level of the main road.

[Drift.]	Grey sandy loam ...	72	132 ft.
	White Chalk, to hard clunch ...	60	

Dr. Armistead's account divides the first 72 ft. into brown loam 10, grey sandy loam 62.
Mr. Ingold remarks that this section shows that the Drift Valley (see pp. 64, 65) decreases in depth on the south.
For analysis of the water, see p. 423.
There is another public pump in the village.

5. School, on Wicken Road.
Made and communicated by Mr. Featherby.
234 ft. above Ordnance Datum. Shaft $50\frac{1}{2}$ ft., then bored.

Mould	...	2	$56\frac{1}{2}$ ft.
[Glacial Drift.]	Boulder Clay ...	$50\frac{1}{2}$	
	Chalky gravel and sand, with water	4	

6. Shirley's Malting. On the western side of the stream, a little north-west of the Great Eastern Railway Station. 1885.
Made and communicated by Mr. G. Ingold.
Less than 200 ft. above Ordnance Datum.
Shaft 16 ft., the rest bored. Water rose to within $9\frac{1}{2}$ ft. of the surface.

		Thickness. Ft.	Depth. Ft.
Gravel	...	16	16
[Boulder Clay, 59 ft.]	Blue marly clay [specimen, at 40, pale grey]	39	55
	Hard chalk, with flints [boulder]	2	57
	Chalky clay	4	61
	Hard stony dark clay	14	75
Chalk	...	45	120

Newport, cont.

7. Shortgrove House.
About 300 ft. above Ordnance Datum.

To Chalk ... about 100 } 250 ft.
Chalk .... ,, 150 }

8. Shortgrove. Bromley. Well 10 ft. deep, in gravel.
Good supply of water. For analysis of the water, see p. 423.

9. Wicken End. 1884. Apparently a fuller account of a well published in *Essex Nat.*, vol. iii, p. 51, as at Mr. Shirley's Villas, Cuckingstool End, about 320 yds. south-south-west of the church, and about 240 ft. above Ordnance Datum.

Made and communicated by Mr. G. Ingold.
Shaft 50½ ft., the rest bored.

		Thickness. Ft.	Depth. Ft.
Mould		2	2
[Glacial Drift.]	Yellow clay	4	6
	Blue clay	3	9
	Sandy loam	5	14
	Dark blue clay	2	16
	Sand	½	16½
	Brown clay	1½	18
	Blue clay	32½	50½
	Chalky gravel and sand, with water	4	54½

Noak Hill.

Ordnance Map 257, new ser. (Essex 67, NW.). Geologic Maps 1, NW. and London District, Sheet 2.

Dagenhams, or Dagnam Park. Sir T. Neaves. Wrongly entered as Dagenham Hall in 'The Geology of London,' vol. ii.
Dr. J. Mitchell's MSS., vol. iii, p. 72.
Over 200 ft. above Ordnance Datum.
Good supply. Water rose 200 ft.

		Ft.
[Valley Drift.]	Brick-earth	1½
	Gravel	3
Blue [London] Clay. About half-way down a bed of fine whitish sand (13 in.), with small pebbles		400
	To sand, about	404

In 1905, the supply depended on one private well (not the above). Several borings have been made, all failures. An old well in Smith's Lane has recently been opened (? 1913), yields a fairly good water, and is the chief source of supply.

In 1913 the South Essex Co. extended its mains, to supply the place.

Nobles Green, see Eastwood.

North Benfleet.

Ordnance Map 258, new ser. (Essex 69, SW.). Geologic Map 1, SE.

1. Public pump. On road-side, about ½ mile east of the Rectory.
About 76 ft. above Ordnance Datum.
Rest water-level 40 ft. down (Surveyor). Depth of well 310 to 315 ft.
For analysis of the water, see p. 424.
It is now in the area of the Southend Co.

2. Rectory.
100 ft. above Ordnance Datum. Dug 65 ft., bored 206. Water from sand.
The reservoir (? widened shaft) was (April, 1898) 64½ ft. deep, and the water just rose into it.

North Benfleet, cont.

In 1895 it was deepened 4 ft., and in 1897, 5 ft., but the water-level has fallen so rapidly that further deepening appears necessary.

For analysis of the water, see p. 424.

According to Dr. THRESH's Report of 1901, p. 84, the population was about 175, scattered and much in want of water, many of the people having to come three-quarters of a mile to the one public pump.

The place is now supplied by the Southend Co.

North Fambridge.

Ordnance Map 258, new ser. (Essex 62, SW.). Geologic Map 1, NE.
Fambridge Railway Station. Edge of Marsh north-east of church. 1888.
Communicated by W. T. FOXLEE, Resident Engineer, Essex Lines.
Original surface 22 ft. above Ordnance Datum. Station-yard excavated down to 20½, from which latter the depths are measured.
Shaft 15 ft., the rest bored.
Water-level 13½ ft. down. Yield, at 28 ft. down, 5 gallons a minute.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Brown clay [? partly Alluvium] ...	18	18
	Blue clay	325	343
	[Basement bed.] Stone	½	343½
	[Basement bed.] Sand and pebbles ...	2½	346
[? Reading Beds, or Oldhaven Beds.]	Running sand	8½	354½
	Blue clay	¾	355¼
	Running sand	5¾	361

An account from Messrs. LE GRAND and SUTCLIFF differs in the details, except of the bottom part, being as follows:—

	Thickness. Ft.	Depth. Ft.
Clay	341½	341½
Stone	½	342
Blue clay	1¾	343¾
Stone	½	344¼
Sand and pebbles ...	1¾	346

According to Dr. THRESH's Report of 1901, p. 110, the supply formerly came from a deep well, which became contaminated. It now comes from the Purleigh District Works (see p. 82).

See also **Fambridge.**

North Ockenden.

Ordnance Map 257, new ser. (Essex 75, SW. and SE.). Geologic Maps 1, SW. and London District, Sheet 2 (but not marked thereon).

According to Dr. THRESH's Report of 1901, p. 70, the scattered population (350) were supplied chiefly from wells, the South Essex Co. supplying about 20 houses. His Report of 1905 says that the Company then supplied about 80 per cent., while 15 per cent. were supplied from the public pump, over a shallow well.

North Shoebury, see **Shoeburyness.**

Oakley, see **Great Oakley** and **Ugley.**

Old Sampford, see **Great Sampford.**

Ongar Rural District.

Ordnance Maps 240, 257, new ser. Geologic Map 1, NW.
Dr. THRESH. Report on the Water Supply of Essex, 1901, p. 60.

The following parishes then got their supply from ponds and wells:— Greensted,[1] Kelvedon Hatch, Norton Mandeville, The Rodings (Abbess, Beauchamp and Berners; the other five Rodings are in the Dunmow Rural District), Stapleford Abbot, Stondon Massey and Theydon Mount[1].

Ongar Rural District, cont.

The following got their supply from wells:—Chipping Ongar,[1] High Ongar[1], Moreton and Willingale.

Fyfield also got some of its supply from the stream. Besides the above, some other places are noticed in this Memoir in their alphabetical order.

[1] These are now supplied by the Herts and Essex Water Company, but there are no other changes.

Orsett.

Ordnance Map 257, new ser. (Essex 75, SE., 76, SW., 83, NE., 84, NW.). Geologic Map 1, SE.

The supply was formerly (1901) from shallow wells. In 1905 about 10 per cent. supplied by the South Essex Co., nearly all the rest from private wells, most about 30 ft. deep but some over 100 ft., and a few used a spring in Baker Street. Many more houses are now supplied by the Co. (1913).

Orsett Union. 1901.
Made and communicated by Messrs. Isler.
70 ft. above Ordnance Datum.
Lined with 60 ft. of 6-in. tubes from 26 ft. down, and with 110 ft. of 5-in. tubes from 16 ft. down.
Water-level 28 ft. down. Supply 600 gallons an hour. Analysis, p. 424.

		Thickness. Ft.	Depth. Ft.
Dug well		—	35
[Oldhaven Beds, Woolwich Beds and Thanet Sand.]	Sand	25½	60½
	Green sand	27½	88
	Clay	6	94
	Grey loamy sand	28	122
	Flints	2	124
[Upper] Chalk and flints		76	200

Osea (a detached part of Great Totham).

Ordnance Map 241, new ser. (Essex 54, NE., 55, NW.). Geologic Map 2.
The Manor House, used as an Inebriate Asylum. Boring. 1904.
Information from the sinker, J. J. Furlong.
Water found at 156 ft. and rose to 21 ft. down. Analysis, p. 425.

		Thickness. Ft.	Depth. Ft.
Soil		3	3
[Drift.]	Gravel	5	8
[London Clay.]	Yellow Clay	12	20
	London Clay	123	143
	Blue Clay	8	151
	Sandy Clay	5	156
	Sand	20	176

Ovington.

Ordnance Map 206, new ser. (Essex 5, SE.). Geologic Map 47.
Public Well. By the roadside, near the Rectory. 1891.
250 ft. above Ordnance Datum.
Made and communicated by Mr. G. Ingold.
Shaft 95 ft., the rest bored. Water-level 102½ ft. down.
Supply, sufficient, but not abundant (1901).
For an analysis of water, presumably from this well, see p. 425.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Brown Boulder Clay	18	18
	Blue Boulder Clay	86	104
	Sharp brown sand	21	125
White chalk with flints		70	195

Paglesham.

Ordnance Map 258, new ser. (Essex 71, NW., SW.). Geologic Map 2.
Dr. THRESH's Report of 1901, p. 79.

Water got from private shallow wells. Quantity sufficient. Quality, on the whole, good.

Panfield and Shalford.

Ordnance Map 223, new ser. (Essex 16, SW., 25, NW.). Geologic Map 47.
Dr. W. W. E. FLETCHER. Report to the Local Government Board, No. 244, p. 8. 1896.

"Water is derived from a large well steined with dry bricks . . no analysis of the water had been made."

Parkeston, see Ramsey.

Parndon, see Great and Little Parndon.

Pebmarsh.

Ordnance Map 223, new ser. (Essex 17, NW.). Geologic Map 47.

According to Dr. THRESH's Report of 1901, p 121, the place was then chiefly supplied from two deep wells, with pumps, yielding a good supply.

H. O. CROSS (Sanitary Inspector) says that there are now (1913) four public wells, as under:—

1. Clay Hills, 56 ft. deep, in clay, to a gravel vein. Water stands about 4 ft. above the bottom. On coming through the rising main the water often smells, but after exposure to fresh air for a short time the smell goes off. To 5 houses.

2. Sudbury Road, a quarter of a mile from 1, also 56 ft. deep. Good supply. To 15 houses.

3. Near the King's Head. A strong upland spring runs into a well about 10 ft. deep, the surplus flowing to a brook. The flow varies slightly during times of drought. To 16 houses.

4. Crossend. About 55 ft. deep. Good supply. To 13 houses.

Other houses are supplied from private wells.

Peldon.

Ordnance Map 242, new ser. (Essex 36, SE.). Geologic Map 48, SW.

1. Peldon Lodge. North of the church. 1907.
Communicated by Dr. COOK, with detailed section from the sinkers, Messrs. A. WILLIAMS and Co.
132 ft. above Ordnance Datum.
A boring. Water-level 110 ft. down.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Blue clay	172	172
	Sandy clay	28	200
[Lower London Tertiaries, 107 ft.]	Grey loamy sand	19	219
	Mottled clay	9	228
	Hard brown clay	15	243
	Hard mottled clay	8	251
	Grey sand and clay	5	256
	Light-brown and green clay	5	261
	Hard green sand	2	263
	Hard sandy clay	42	305
	Conglomerate	2	307
[Upper] Chalk and flints		243	550

For analysis of the water, see p. 425.

Peldon, cont.

2. Opposite Brickhouse Farm. Parish well.

Dr. J. W. Cook's Report for 1900. Repeated in Dr. Thresh's Report of 1901, p. 135.

70 ft. deep. Yields an excellent supply, but the water has to be carted to the houses. Some distant houses have wells.

According to the *Essex County Standard*, 25th April, 1908: "In Peldon they have a deep well drawing water from the chalk, and this supplies water to the population of a large area." This must refer to one of the above.

Pentlow.

Ordnance Map 206, new ser. (Essex 5, NE., 6, NW.). Geologic Map 47.

Public well? Made and communicated by Mr. G. Ingold. 1895.

Small supply of water at 18 ft.

		Thickness. Ft.	Depth. Ft.
[Boulder Clay.]	Yellow clay	11	11
	Chalky clay	7	18
	Brown clay	3	21
	Chalk [a boulder] ...	2	23
	Blue Boulder Clay ...	7	30

Besides the above there is another public well 120 ft. deep. The water in both is very good. There is a private well, 100 ft. deep, the supply from which has been frequently deficient.

Pewit Island, see **Great Oakley.**

Pitsea.

Ordnance Map 258, new ser. (Essex 77, NW.). Geologic Map 1, SE.

According to Dr. Thresh's Report on the Water Supply of Essex, 1901, p. 84, the population was about 400, and some of the inhabitants had to go three-quarters of a mile for water.

1. British Explosives Syndicate. On the marsh on the eastern side of Pitseahall Fleet, about five-sixths of a mile southward of the railway station. 1897.

10 ft. above Ordnance Datum (15-20 according to the manager).

Communicated by the Syndicate.

Yield with continuous pumping, at 100 ft. down, 9,000 gallons a day; at 150, 13,000 gallons; at 200, 17,000 gallons; at 250, 20,000 gallons a day. In 1910, at 320, 750 gallons an hour.

Water-level 6 ft. down in 1898. Said to be the same in 1900.

Boring, piped to 409 ft. down with $7\frac{1}{2}$-in. tubes, and with $6\frac{1}{2}$-in. tubes to 404 ft. down.

			Thickness. Ft.	Depth. Ft.
[Alluvium] Marsh-clay			14	14
[London Clay, 233 ft.]	Hard brown clay		18	32
	Dark hard clay		18	50
	Very stiff brown clay		8	58
	Stiff brown clay...		2	60
	Brown clay		10	70
	Very stiff dark brown clay		10	80
	Hard dark clay with dark claystone at $162\frac{1}{2}$ to 163 ft. 1 in.		$88\frac{1}{2}$	$168\frac{1}{2}$
	Dark clay		$3\frac{1}{2}$	172
	Hard dark clay		30	202
	Very hard dark clay		14	216
	Hard blue clay		6	222
	Very hard dark blue clay		10	232
	Very hard dark clay, with two bands of claystone		10	242
	[? Basement-bed.]	Very hard dark sandy clay	$4\frac{1}{2}$	$246\frac{1}{2}$
		Very hard black gravel [pebbles] ...	$\frac{1}{2}$	247

Pitsea, cont.

		Thickness. Ft.	Depth. Ft.
[Oldhaven Beds, Woolwich Beds and Thanet Beds, 147½ft.]	Blackwall rock [? pebbles]	3¼	250¼
	Hard bound sand with shells	1½	251¾
	Sand [and] gravel with shells	8¼	260
	Hard bound sand and gravel [pebbles]	½	260½
	Hard bound sand and shells with flint gravel [pebbles]	4½	265
	Hard bound sand and shells	1	266
	Black sandy clay with gravel [pebbles] very hard	1½	267½
	Hard black sand	2	269½
	Black sand	¾	270¼
	Light-coloured running sand	4¾	275
	Light-coloured clay with gravel [pebbles]	3	278
	Running sand	4	282
	Grey running sand	18	300
	Dark greenish running sand	10	310
	Running sand	6	316
	Dark greenish sand	27	343
	Hard sand	7	350
	Hard dry sand	24	374
	Hard sand	10	384
	Very hard clay (hard stone met with)	10½	394½
[Upper and Middle Chalk, 460½ ft.]	Chalk with flint nuggets	286½	681
	Darker and harder chalk with flints ...	4	685
	Chalk with no flints	35	720
	Harder chalk	12	732
	Chalk	118	850
	Very much harder chalk	5	855

For analysis of the water, see p. 426.

Not only was there shortage in the yield here, but great trouble was caused by grit and sand occurring in the water to a considerable extent.

2. Pitsea Hill. Rectory.

From H. W. Bristow's Notes.

To green sand [? Reading Beds] 400 ft. Abandoned, having dried up.

3. Pitsea Marshes. Old well.

Information from Mr. Purkis, the sinker, to W. H. Dalton.

Alluvium (clay) ...	90	To water 300 ft.
London Clay ...	210	

4. Public well. At side of main road at the boundary of Bowers Gifford Parish.

Information from the Surveyor, Billericay Rural District Council.

About 70 ft. above Ordnance Datum.

Rest-water-level about 120 ft. down (said to fluctuate).

Said to be dug to 370 ft. Pump-tube lengthened three times (10 ft. each time) in the last 30 years (1898).

According to Dr. Thresh in summer this well often failed to give the larger supply then needed. The supply now comes from the Southend Co.

For analysis of the water, see p. 426.

5. Railway Station. Between the old and the new lines. 1889.

42 ft. above Ordnance Datum.

Made and communicated by Messrs. Le Grand and Sutcliff.

Water-level 28 ft. down. Abandoned (dried up).

Pitsea, cont.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Brown clay	10	10
	Blue and brown streaky clay	25	35
	Blue clay	236	271
	Sandy clay	12	283
	Sand, shells and pebbles [? basement-bed]	2	285
Hard blue clay	... ...	3	288

6. Southend Water Co.'s No. 17 or Nevendon Well. Two miles S of Wickford Church. 1907.

Communicated by E. C. Bilham, Engineer to the Company.

42 ft. above Ordnance Datum.

Sunk 273½ ft., 20-in. pipe to 398 (1907).

Highest water-level 93·25 ft. down. Lowest (pumping) 273·5 (boring being deepened. Then 438 ft.).

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil... ...	... ...	2	0	2	0
[London Clay.]	Brick-earth	11	0	13	0
	London Clay	257	0	270	0
[Lower London Tertiaries, 141 ft.]	Sand and pebbles	0	6	270	6
	Sandy clay	30	9	301	3
	Green sandy clay	30	9	332	0
	Green sandy clay and shells	5	0	337	0
	Green plastic clay	4	0	341	0
	Green sand and shells, slightly increased yield at 344...	3	0	344	0
	Dark muddy soft sand ...	53	0	397	0
	Stiff sandy clay	10	0	407	0
	Stiff clay	3	6	410	6
	Flints	0	8	411	2
[Upper] Chalk	... ...	40	10	452	0

At this point the yield markedly increased. Boring was continued. Water both from Chalk and sands of Lower London Tertiaries.

7. At Great Charltons (Chalvedon of newer map). Nearly a mile W. of N. from Pitsea Church. According to Dr. Carter, M.O.H., of Billericay District Council, there is a well dug for 60 ft. and bored for 280.

Plaistow, see **West Ham.**

Pledgdon Green, see **Henham.**

Pleshey.

Ordnance Map 240, new ser. (Essex 33, SW., 43, NW.). Geologic Map 47

In his Report to the Chelmsford Rural District Council for 1895, Dr. Thesh says: "The sand lying beneath the boulder clay, does not yield a very abudant supply of water," so that the two public pumps had to be supplemented by a third well in the higher part of the parish. There are also a few shallow private wells. A few outlying cottages have no supply (1913).

Potter Street, see **Harlow.**

Potten Island (in two parishes).

Ordnance Map 258, new ser. (Essex 71, SW.). Geologic Map 2.

Old wells. Information from Mr. Purkis to W. H. Dalton.

Through Alluvium and London Clay, to sand and water, 485 ft. Another well some yards off is said to have passed through 778 ft. of dry clayey loam; but there must be some mistake (?478).

Purfleet, see **West Thurrock.**

Purleigh.

Ordnance Map 241, new ser. (Essex 53, SE., 54, NE., 61, NW., 62, NE.).
Geologic Map 1, NE.
Purleigh Hall. Old well.
Information from Mr. HATLEY, the sinker, to W. H. DALTON.
To the base of the London Clay, 400 ft.

There are two other deep wells, one at a baker's, near and eastward of the church, the other at the road-side at the foot of the hill, less than half a mile N.W. of the church. Both give a soft alkaline water.

The well at Purleigh Station is in Cold Norton, which see.

Prittlewell, see Southend.

Quendon.

Ordnance Map 222, new ser. (Essex 13, NE., SE.). Geologic Map 47.

1. Hall Lane.
Sunk and communicated by Mr. G. INGOLD.
Shaft 40 ft., the rest bored. Water at 29 ft.

Gravel and clay	18	95 ft.
Soft white Chalk, with flints ...	77	

2. Public Well, by the side of the high road at Quendon Farm, and over a quarter of a mile south-south-west of the church. 1887.
Made and communicated by Mr. G. INGOLD.
About 290 ft. above Ordnance Datum. Dug throughout.
Fast spring. Water stands 3 ft. from the bottom.

		Thickness. Ft.	Depth. Ft.
Boulder Drift.	Brown clay	10	10
	Sand	2	12
	Gravel	10	22
	Blue clay	9	31
	Brown clay (dip to W.)	5	36
	Gravel and sand ...	43½	79½

Carried into the Chalk.

3. Another well, about half-way down the street on the western side. 1857?
From Mr. G. INGOLD.
[Drift] Gravel and sand, 80 ft.

Three other wells on the same side of the street have gravel at the bottom, while those on the eastern side have Chalk.

4. The Hall. 300 ft. above Ordnance Datum. 1907.
Made and communicated by Messrs. LE GRAND and SUTCLIFF.
A 5-in. boring. Water-level 89 ft. down (1908).

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Dug well (the rest bored) ...	—	89½
	Bricks, rubbish and sand ...	8	97½
	Sand and blue clay	8	105½
	Flints and chalk stones ...	12½	118
	Coarse sand, flints	24	142
Chalk and flints		30	172

For an analysis of the water, see p. 429.
In an old well at the Hall, 90 ft. deep, there is red sand at the bottom.

Quendon, cont.

5. The Hall Laundry, at the northern end of the village, near the inn.
Made and communicated by Messrs. LE GRAND and SUTCLIFF.
275 ft. above Ordnance Datum.
Bored to 133 ft. in 1909. Deepened to 148 ft. in 1911.
Water-level 65 ft. down.

		Thickness. Ft.	Depth. Ft.
Concrete		½	½
[Glacial Drift.]	Gravel and flints	49½	50
	Clay, sand and chalk	5	55
	Loam	2	57
	Sand	4	61
	Gravel	3	64
Chalk and flints		84	148

For analysis of the water, see p. 429.

6. Trial-boring of the South Essex Water Trust.
Communicated by Messrs. ROFE.
? Between road and railway about two-thirds of a mile north east of the church.
212·47 ft. above Ordnance Datum.
Water-level, 13th April, 1900, 5½ ft. down.

		Thickness. Ft.	Depth. Ft.
Soil		½	½
[Drift.]	Clay	1¾	2¼
	Gravel	12	14¼
	Gravel and sand	3	17¼
Chalk with flints		12¾	30

For analysis of the water, see p. 429.
In 1901 there were about 10 private wells, 70 to 180 ft. deep.

Radwinter.

Ordnance Map 222, new ser. (Essex 9, NE., SE., 10, NW., SW.).
Geologic Map 47.

1. Almshouses, on the southern side of the church. 1888.
Made and communicated by Mr. G. INGOLD.

Mould		3	25 ft.
[Boulder Clay,]	White clay	2	
	Brown clay	9	
	Blue clay	11	

2. Brewery, near the church.
273¾ ft. above Ordnance Datum.
Sunk and communicated by Mr. G. INGOLD.
Shaft 28 ft.; the rest bored, 4 in. diameter.
Water-level 65 ft. down (? 75 ft. down in 1900).

		Thickness. Ft.	Depth. Ft.
Made earth		1	1
[? Boulder Clay.]	Brown clay	4	5
	White clay	5	10
	Dark stony clay	4	14
	Blue clay	41	55
Chalk		53	108

Radwinter, cont.

3. Grange Farm. 1899.
Made and communicated by Mr. H. G. FEATHERBY.
323 ft. above Ordnance Datum.
Shaft 43 ft., the rest a boring of 6 in. diameter in the clear; lined to about 100 ft. down.
Water-level (July, 1900) in well 42 ft. down, in boring 55½ ft. down.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Brown clay	12	12
	Blue clay	30	42
	Gravel and sand ...	6	48
	Blue clay	32	80
	Sand	1	81
	Gravel	5	86
	Clay	5	91
Chalk.	Loose rubbly chalk ...	5	96
	Hard white chalk ...	54	150

For analysis of the water, see p. 429.
According to the Medical Officer (W. ARMISTEAD), 1913. There is a public pump, the water coming from a spring, and a private well opposite the almshouses (? No. 1) is used by the public.

Rainham.

Ordnance Map 257, new ser. (Essex 74, SE., 75, SW., 82, NE.).
Geologic Map 1, SW. and London District Sheet 2.

1. Cold Harbour Shoots. Messrs. W. and R. Cunis. March, 1908.
Made and communicated by Messrs. DUKE and OCKENDEN.
About 5 ft. above Ordnance Datum.
Bored throughout. Lined with 6-in. tubes to 454 ft.
Water-level 4½ ft. down. Yield tested at 206 ft., 700 gallons an hour.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Clay	6	6
	Clay and peat	14	20
	Clay and woodstone ...	7	27
[River Drift]	Coarse gravel	13	40
Chalk and flints	... ...	466½	506½

Another account of the above.

	Thickness. Ft.	Depth. Ft.
Clay	7	7
Peat	20	27
Sand and gravel ...	18	45
Chalk and flints ...	511	556

This account adds that the water was brackish. The boring was deepened to 556 ft. later.
This may be in Wennington and in Ordnance Map 271.

2. Rainham Creek. Wickens, Pease and Co. Creek Mouth (Frog Island ?). No. 1 Well. 1901.
Made and communicated by Messrs. ISLER.
Lined with 171 ft. of 6-in. tubes, and with 89 ft. of 5-in tubes from 147 to 236 ft. down; then with 100 ft. of 4-in. tubes to 346 ft. down.
Water-level 27 ft. down. For an analysis of the water, see p. 430.

		Thickness. Ft.	Depth. Ft.
[Alluvium]	Clay, peat, etc.	38	38
[River Drift, 40ft.]	Ballast [gravel]	1½	39½
	River sand	14½	54
	Ballast [gravel]	24	78
London Clay [and Lower London Tertiaries]	...	147	225
[Upper] Chalk	... ...	121	346

Rainham, cont.

3. Messrs. Wickens, Pease and Co. No. 3 Well. 96 ft. from river-bank and 114 ft. from Creek mouth (Field 919 of 25-in. Ordnance Map).

Made and communicated by Messrs. A. WILLIAMS and Co. (A slightly different and less detailed account from Messrs. WICKENS, PEASE and Co.)

Water-level 10 ft. down.

		Thickness. Ft.	Depth. Ft.
Well (the rest bored)		—	7
Made ground		13	20
[Alluvium] Clay and peat		11	31
[? River Drift, 42 ft.]	Pebbles and sand	14	45
	Live sand and pebble	3	48
	Clay, pebbles and sand	14	62
	Clay and pebbles	11	73
[? London Clay]	Clay	10	83
	Tough blue clay	11	94
[? Oldhaven Beds and Woolwich Beds.]	Hard sands	5	99
	Black pebbles	9	108
	Sand and pebbles	16	124
	Black pebbles and sand	8	132
	Live sand and pebbles	24	156
	Green sand and pebbles	9	165
[Thanet Sand, 58 ft.]	Hard grey sand	22	187
	Green sand	3	190
	Grey sand	33	223
[Upper] Chalk and flints		3	226

For analysis of the water see p. 430. The high chlorides will be noticed. Another well here, going 100 ft. into the Chalk, yields less water but it has 10 to 20 grains less of chlorine per gallon.

The following further information was given, in April, 1909, by Mr. T. SOMERVILLE, Secretary to the firm:—

There are two wells. No. 1 is about 350 ft. deep, being 150 into the Chalk. As it was impossible to get anything like an adequate supply from the Chalk (only about 600 gallons an hour being got), cartridges were exploded in the Chalk, which broke the seal between the well and the Chalk, and therefore the water in the Chalk and the water above the Chalk now join.

The second well (known as No. 3) is carried only to the top of the Chalk and does not enter it. It is about 200 ft. NW. of the first.

They can pump about 6,000 to 7,000 gallons an hour from either well.

The water-level, before pumping, is about 17 ft. down, and there is practically no difference between the two wells, as it has been found that they connect [in the matter of water].

Water does not circulate at all freely in the Chalk, and two other wells in the district (practically identical with ours) have needed explosions, above the Chalk, to get an adequate supply. One is close by the Three Crowns inn and the other is at the Chemical Works north of Frog Island (field 245).

4. Rainham Ferry. Messrs. J. C. and J. Field's Soap and Candle Factory. At the northern end of the factory and about 200 yds. from the river-bank. 1904.

Made by Messrs. ISLER. Communicated by Messrs. FIELD and Messrs. ISLER.

Between 5 and 10 ft. above Ordnance Datum.

A 5-in. bore. Lined with 150 ft. of 6-in. tubes and 215 ft. of 5-in.

Rainham, cont.

Water-level about 5 ft. down. Yield 1,200 gallons an hour. The first water met with was brackish and was kept out by tubing. The lower water in the Chalk was perfectly good. There is reason to believe that the brackish water rapidly destroys the tubes.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Clay	3	3
	Boggy earth	18	21
[River Drift] Black gravel and sand		22	43
[? Blackheath Beds and Woolwich Beds.]	Blue clay and pebbles ...	22	65
	Grey sand and large pebbles ...	25	90
	Sand and pebbles	7	97
	Loamy green sand and pebbles	28	125
Grey sand [Thanet]		56	181
[Upper] Chalk and flints		169	350

5. Rainham Shoots. Messrs. Shelbourne and Co. (now Messrs. Cory). Made and communicated by Messrs. Duke and Ockenden. December, 1905.

Tubes to 293 ft. down.

Water-level 25 ft. down. Fair supply.

		Thickness. Ft.	Depth. Ft.
[? Made ground] Ashes		20	20
[Alluvium] Peat and clay		18	38
[River Gravel, 16 ft.]	Gravel and sand... ...	7	45
	Gravel	1	46
	Sand and gravel ...	8	54
[London] Clay		62	116
[? Blackheath Beds] Gravel [? pebbles] ...		32	148
[Reading Beds, 46 ft.]	Sand	19	167
	Clay	27	194
[Thanet] Sand (green)		36	230
[Upper] Chalk...		205	435

6. Messrs. Salamon. 1907.

Made and communicated by Messrs. Isler.

Lined with 50 ft. of $7\frac{1}{4}$-in. tubes, 220 ft. of 5-in. tubes, 70 ft. of 4-in. sand-screen (perforated) tubes, and 10 ft. of 4-in. plain tubes.

Water-level 9 ft. down.

		Thickness. Ft.	Depth. Ft.
Made ground		1	1
[Alluvium.]	Light-coloured clay	7	8
	Peat	18	26
[River Gravel] Ballast		20	46
[London Clay.]	Blue clay	$48\frac{1}{2}$	$94\frac{1}{2}$
	Clay and black pebbles ...	$12\frac{1}{2}$	107
[Oldhaven Beds] Sand and pebbles		19	126
[Woolwich Beds.]	Hard grey chalk [? what] ...	2	128
	Hard green sand	$1\frac{1}{2}$	$129\frac{1}{2}$
	Soft „ „	8	$137\frac{1}{2}$
	Grey sand and pebbles... ...	8	$145\frac{1}{2}$
	Green sand	$18\frac{1}{2}$	164
[Thanet Sand.]	Light-grey sand	7	171
	Dark grey sand	$45\frac{1}{2}$	$216\frac{1}{2}$
[Upper Chalk.]	Chalk and flints	1	$217\frac{1}{2}$
	Chalk (white)	$189\frac{1}{2}$	407

Rainham, cont.

7. Half-a-mile north of St. Peter's Church, Wennington, and known as the Wennington Well.
Trial-boring for the South Essex Waterworks Co. 1902.
Communicated by W. B. BRYAN, Engineer to the Co.
27 ft. above Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
Soil		3½	3½
[River] Gravel		11	14½
London Clay		170	184½
[? Oldhaven Beds and Woolwich Beds.]	Shells and pebbles	8½	193
	Sandy clay and shells	13	206
	Hard sand and shells	12	218
	Live sand and water	2	220
	Dead sand and water	2	222
	Black peat [lignite]	8	230
	Black clay	6	236
	Hard green sand	10	246
[? Thanet Sand] Grey sand and water, into brown sand and pebbles		7	253

Ramsden Bellhouse.

Ordnance Map 258, new ser. (Essex 60, SE., 68, NE.). Geologic Map 1, NE.
According to Dr. THRESH's Report on the Water Supply of Essex, 1901, p. 84, the population was about 400. The water-supply was got from a spring and a few shallow wells, at least two of which yielded undrinkable water (? from mineral matter. Report of 1905, p. 37).

1. Old well. Information from Mr. PURKIS, the sinker, to W. H. DALTON.

London Clay ...	310	350 ft.
Sand, to water ...	40	

2. Southend Water Co.'s Well No. 27, or Ramsden Heath Well. 1½ miles NNW. of Ramsden Bellhouse Church. 1914.
Communicated by E. C. BILHAM, Engineer to the Company.
187 ft. above Ordnance Datum.
Highest water-level 225·25 ft. down. Lowest (pumping) 424.
Sunk 464 ft., 24-in. tubes to 502 and 20-in. to 491, perforated from 469 to 473.

		Thickness. Ft.	Depth. Ft.
Soil		1	1
Gravel and clay		3	4
[London Clay.]	Yellow clay	5	9
	Brown sandy clay	3½	12½
	Blue sandy clay	17	29½
	London Clay	438	467½
[Lower London Tertiaries.]	Pebbles, clay and sand	15	482½
	Sand and clay	2	484½
	Soft sand	1	485½
	Black mixture	3	488½
	Sand and shells	7	495½
	Sharp sand	4	499½
	Sharp sand; pyrites	2	501½

Ramsden Crays.

Ordnance Map 258, new ser. (Essex 68, NE.). Geologic Map 1, NE.
According to Dr. THRESH's Report of 1901, p. 85, the population was 200; building was stopped for want of water; the supply was from a spring and a few shallow wells; and new houses were provided with rain-water-tanks.

Ramsden Crays, cont.

Crays Hill. Old well (? parish well).
Information from Mr. PURKIS, the sinker, to W. H. DALTON.

[London Clay.]	Clay and sand ...	30	470 ft.
	Clay	400	
[? Reading Beds.]	Sand, to water ...	40	

Both the Ramsdens are within the area of the Southend Co. (1913).

Ramsey.

Ordnance Map 224, new ser. (Essex 20, SE., 21, SW.).
Geologic Map 48, NE.

1. New Farm House (after 1870) ? South-west of Copperas Wood (not named on the newer map). The site may be somewhere between Stour Hall and Stourwood Farm.

Communicated by E. W. GARLAND.

Through London Clay to a bed of marl with plenty of water, which however, is unfit for drinking or for cooking purposes, being very unwholesome; about 90 ft.

2. Ramsey Ray. North-eastern end of the island, now Parkeston. 1880? Trial-boring. Communicated by J. B. CRAWFORD.
18 ft. above Ordnance Datum.
Water brackish; stands at 2 ft. 4 in. above Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
[London Clay, 36½ ft.]	Yellow clay	9	9
	Blue clay	27½	36½
[Reading Beds, 50 ft.]	Dark grey sand	1½	38
	Brown clay	15	53
	Light-coloured sand ...	6½	59½
	Dark loamy sand ...	4¾	64¼
	Dark hard clay	4¾	69
	Grey sand	2½	71½
	Brown clay	8	79½
	Green sand	¼	79¾
	Brown clay	4¼	84
	Green sand	2½	86½
[Upper] Chalk	... ...	110	196½

According to Dr. THRESH'S Report of 1901, p. 127, the mains of the Tendring Hundred Co. pass through large part of the parish, and a supply was taken by many houses along the line and in the village, as well as by Parkeston. The rest used shallow wells.

Rawreth.

The name does not appear as a parish on the new map.
Ordnance Map 258, new ser. (Essex 69). Geologic Map 1, NE.

1. Rectory. Old well.
Information from Mr. PURKIS, the sinker, to W. H. DALTON.

London Clay ...	235	275 ft.
Sand, to water ...	40	

2. According to Dr. THRESH'S Report of 1901, p. 79, there was a bored well at Burrell's Farm, yielding a plentiful and good supply; but the greater part of the parish used shallow well-water, in places of doubtful character, supplemented by rain-water-tanks in some cases.

Rayleigh.

Ordnance Map 258, new ser. (Essex 69, SE.). Geologic Map 1, SE.

1. Lubard Lodge. 1905.
Made and communicated by Messrs. ISLER and Co.
Lined with 211 ft. of 5-in., 180 of 3-in., and about 268 of $2\frac{1}{4}$-in. tubes.
Water-level 90 to 100 ft. down.

		Thickness. Ft.	Depth. Ft.
Blue [London] Clay ...	... ...	410	410
[Lower London Tertiaries.]	Loam sand ...	89	499
	Green sand ...	2	501
	Loam sand ...	49	550
[Upper] Chalk and flints	... ...	$1\frac{1}{2}$	$551\frac{1}{2}$

2. A mile north of the town.
PRESTWICH, *Quart. Journ. Geol. Soc.*, vol. x, p. 407, and MS.
London Clay 400 ft. deep. Water 110 ft. down.

Dr. THRESH, in his Report on the Water Supply of Essex, 1901, p. 79, says that there were two public wells, one yielding good water, but in limited quantity, the other found to be polluted, and condemned, on analysis. A number of private shallow wells, many yielding water of inferior quality, formed the principal supply.

The supply is now taken from the Southend Co. (1913).

Rayne.

Ordnance Map 223, new ser. (Essex 25, SW.). Geologic Map 47.
Rayne Hall.
Sunk and communicated by Mr. G. INGOLD.
[Glacial Drift.] Gravel and sand, $17\frac{1}{2}$ ft.

Rettenden.

Ordnance Map 258, new ser. (Essex 61, 69, NE., NW.).
Geologic Map 1, NE.

1. Battlesbridge.
PRESTWICH, *Quart. Journ. Geol. Soc.*, vol. x, p. 407; and Dr. J. MITCHELL'S MSS., vol. iii, p. 79. Water overflowed (PRESTWICH MS.).
Vegetable mould and gravel at top.
London Clay, to 'water-rock' and sand, 350 ft.

2. Battlesbridge. Mr. W. Clarke's, about half a mile from the River Crouch.
Junction of Battlesbridge and Runwell Roads. 1884.
Probably about 80 ft. above high-water mark.
Sunk and communicated by Messrs. LE GRAND and SUTCLIFF.
Bored throughout. Water-level $64\frac{1}{2}$ ft. down.

		Thickness. Ft.	Depth Ft.
Soil	... ...	$10\frac{1}{2}$	$10\frac{1}{2}$
[London Clay.]	Clay, with occasional thin clay-stones	395	$405\frac{1}{2}$
	Sandy clay	8	$413\frac{1}{2}$
	Stone	$\frac{1}{2}$	414
[? Reading Beds.]	Green sand	7	421
	" " with water ...	2	423

It is possible that the green sand may be merely the wet sandy basement-bed of the London Clay. Even if not so the depth to the bottom of the London Clay would be 414 ft., which shows a great thickness of that formation, the top part of which is not here present.

Rettenden, cont.

3. Battlesbridge Railway Station. 1888.
Communicated by W. T. FOXLEE, Resident Engineer, Essex Lines, and by Messrs. LE GRAND and SUTCLIFF.
$22\frac{1}{4}$ ft. above Ordnance Datum.
Shaft 32 ft., the rest bored.
Water rose to within 24 ft. of the surface, at the rate of 5 gallons a minute.

[London Clay.]	Clay?	32	365 ft.
	Blue clay	331	
[Reading Beds?]	Sand and water ...	2	

4. The Hall. Old well.
Information from Mr. PURKIS, the sinker, to W. H. DALTON.

London Clay ...	350 to 360	390 to 400 ft.
Sand, to water ...	40	

Rickling.

Ordnance Map 222, new ser. (Essex 13, NE. and SE.). Geologic Map 47.

1. Brick-kiln Cottage [? southward of], about a third of a mile west of 'The Views,' and less than a mile south-south-east of the church.
A little over 300 ft. above Ordnance Datum.
Made and communicated by Mr. G. INGOLD.
Shaft throughout.

		Thickness. Ft.	Depth. Ft.
[Boulder Clay.]	Brown stony clay	15	15
	Blue clay	5	20
	Brown clay with stones ...	2	22
[Glacial Gravel, etc.]	Gravel	18	40
	Loam and sand	7	47
	Sand	4	51
	Loam	5	56
	Sand and large flints	4	60
	Sand and gravel	18	78
	Yellow loam	3	81
	Sand	1	82
	Gravel and large flints ...	1	83
Chalk ...	... ...	3	86

The Chalk comes to the surface less than 200 yds. NNW.

2. An old well at 'The Views,' a little north-west of the last.
Communicated by Mr. INGOLD.
Over 300 ft. above Ordnance Datum, 100 ft. deep, 3 ft. being in Chalk.

3. Rickling Green. South-western end.

[Glacial Drift.]	Boulder Clay ...	25	? 95 ft.
	Gravel and sand...	35	
Chalk	... ...	? 35	

According to the Report of the Medical Officer, for 1912, there is a public pump, the water coming from a well into Chalk, 93 ft. deep.

Ridgewell.

Ordnance Map 206, new ser. (Essex 5, SW., 11, NW.). Geologic Map 47.

Speaking of this village, in his Report on the Halstead Registration District, Dr. R. B. LOW says: "The water supply is obtained from a well . . near the lower end of the village. Some persons also fetch drinking water from an open spring in the private park of one of the landowners"; but many cottagers get water "from the dammed-up ditches which are contaminated before their eyes." Report to the Local Government Board, No. 44, 1889.

Ridgewell, cont.

There was a public pump on the village Green and a public spring which had been protected and provided with a pump (Dr. THRESH's Report of 1901, p. 121). His Report of 1905, p. 65, adds that the two public pumps supplied 85 per cent. of the people. A few were supplied from private wells. A few had to go a mile for water.

Rivenhall.

Ordnance Maps 241, 223, new ser. (Essex 34, NE., 35, NW., SW.)
Geologic Map 47.

According to Dr. THRESH's Report of 1905, p. 6, the supply was then wholly from private wells (presumably through Boulder Clay to gravel) and was not wholly satisfactory.

Rochford.

Ordnance Map 258, new ser. (Essex 70, SW. and SE.). Geologic Map 1, SE.

1. Stroud or Strood Green, west of the town.
PRESTWICH, *Quart. Journ. Geol. Soc.*, vol. x, p. 407.
London Clay, 390 ft.

2. The Union.
PRESTWICH, *Quart. Journ. Geol. Soc.*, vol. x, p. 407.
London Clay [including River Drift] to sand, 230 ft.

According to the Master (1887) the shaft was originally 50 ft., but was deepened to 70, the 20 ft. being all in clay. The water-level was over 50 ft. down, and was pumped down to the bottom of the shaft.

Later information, from G. R. STRACHAN (1894), makes the Workhouse well continued, by boring, to the depth of 390 ft.

According to Mr. PURKIS, the section is much like that at the Post Office (No. 5), but with 6 or 8 ft. more gravel.

3. There is an old well, in Market Square; with a shaft of 100 ft., and then a bore (information from Mr. ASBEY).

According to G. R. STRACHAN this town-well is bored to the depth of 460 ft.

4. In Sir J. PRESTWICH's MSS. is a note of a well in Plumberrow Lane, in which the water was 100 ft. down and the London Clay was 430 ft. thick!

5. Post Office. Old well.
Information from Mr. PURKIS, the sinker, to W. H. DALTON.

Gravel	28	310 ft.
London Clay ...	282	

Dr. THRESH, in his Report of 1901, p. 79, says that the population was 1,612. There were several good private shallow wells. The public well, in the square, had recently failed, and the Rural District Council had to supply water by cart from a private well.

The place is now supplied by the Southend Co. (1913).

Romford.

Ordnance Map 257, new ser. (Essex 66, SE., 74, NE.). Geologic Maps 1, S.W., and London District, Sheet 2.

1. Havering Mead. By Longfield House. Romford Pumping Station.
South Essex Waterworks Co. 1886.
? 32½ ft. above Ordnance Datum.
Made and communicated by Messrs. TILLEY, and from other sources.

Romford, cont.

Shaft 42 ft., the rest bored. The shaft deepened since, as it is 240 ft deep, and the floor of the adit is 228½ ft. from the surface.

Water-level 46 ft. 8 in. down, at rest; lowered to 72 ft. 1 in. by pumping (? before 1900).

			Thickness. Ft.	Depth. Ft.
[London Clay.]	Yellow clay		9	9
	Blue clay		33	42
	[? Basement-bed.]	Dark dead sand	4	46
		Live sand, with water	5	51
		Hard stone	1	52
[Woolwich and Reading Beds, 38½ ft.]	Black clay		1	53
	Black sand and shells		1	54
	Black clay and shells		2	56
	Shells		2	58
	Black sand and shells		3	61
	Dark dead sand		2	63
	Light-coloured live sand		4	67
	Brown live sand		2	69
	Dark brown clay		1	70
	Green live sand		3	73
	Dead green sand		9	82
	Dead dark sand		8	90
	Pebbles		½	90½
[Thanet Sand, 73⅓ ft.]	Live light-coloured sand		64½	155
	Dead dark sand		8	163
	Flints		10 ins.	163¾
[Upper.] Chalk			224⅔	388½

The average daily quantity pumped in 1910 was 243,375 gallons.

For analyses of the water, see p. 431.

2. Ind, Coope and Co.'s Brewery. (Published 1872.)
Sunk and communicated by Messrs. S. F. Baker and Sons.

		Thickness. Ft.	Depth. Ft.
[Soil, etc. (on the authority of S. V. Wood, Jun.)]		7	7
[River] Gravel		9	16
[London Clay, 31 ft.]	Blue clay	29	45
	Stone [basement-bed ?]	2	47
[Woolwich Beds, 55 ft.]	Green sand and pebbles	18	65
	Loamy sand	17	82
	Bright green sand	20	102
[Thanet Sand, 50 ft.]	Green sand with veins of clay...	32	134
	Hard dark blue clay (to flints)	18	152
[Upper] Chalk		298	450

Mr. Wood got some of the regular fossils of the Woolwich Beds from the sands. If the 7 ft. of soil be omitted, as in Messrs. Baker's account, the depth to the Chalk is reduced to 145 ft. For analysis of the water, see p. 431.

3. Hornchurch Lane. Old well.

In Sir J. Prestwich's MSS. is a note of a well through 25 ft. of gravel and 30 to 40 ft. of blue clay. The water overflowed.

In Dr. J. Mitchell's MSS., ? vol. iii., two old wells at Romford are noted as giving the same section as that of Dagenham No. 1 (p. 135).

Rowhedge and **East Donyland.**

Ordnance Map 224, new ser. (Essex 37, NW.). Geologic Map 48, SW.

1. East Donyland. Heath House. (Mr. Daniell's.) 1899.
Made and communicated by Messrs. Le Grand and Sutcliff.
75 ft. above Ordnance Datum.
Water-level 65 ft. down (? 75 ft. down in 1900).

Rowhedge, cont.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift] Sand and ballast [gravel]		16	16
[London Clay, 106 ft.]	Blue clay	44	60
	Sandy blue clay, with a foot of clay-stone at the bottom	43	103
	Sand and clay	19	122
[Reading Beds, 88 ft.]	Coloured [mottled] clay	29	151
	Green sand	4	155
	Grey sand	15	170
	Dark sandy clay	40	210
[Upper] Chalk and flints		55	265

For analysis of the water, see p. 431.

2. East Donyland. Steam Brewery. Messrs. Daniell's. 1855 or 1856.
Information from Messrs. Daniell, P. Bruff, and H. A. Adams.
About 7 ft. above Ordnance Datum.
Shaft 11 ft., the rest bored.

Water-level (1855 or 1856) was at the surface. 4 ft. down (1883?). In 1898, 9 ft. down, or according to J. M. Wood, about 13 ft. down, being reduced by pumping to about 21 ft. down. After 25 years' pumping (from the beginning) only reduced 18 in. Not affected by tide.

Supply good and abundant. In summer over 500 barrels a day often used.

	Thickness. Ft.	Depth. Ft.
Drift sand and gravel	3	3
London Clay and Lower London Tertiary sands	120	123
Upper Chalk	182	305

Another account makes the depth to the Chalk 130 ft.
For an analysis of the water, see p. 431.

3. At the eastern end of the village. For public supply. 1902.

Dr. J. C. Thresh's Report on the Water Supply of the County of Essex, 1901, pp. 68, 69, and The Water Supply to Rural Districts of Essex, 1905. Details also from Messrs. Isler and Co., who made the boring.

12·5 ft. above Ordnance Datum.
Lined with 115 ft. of $7\frac{1}{4}$-in. tubes level with the surface.
Water-level 9 ft. down. Supply 7,600 gallons an hour.

14 days' pumping at 6,500 gallons an hour only reduced the water-level by 7 ft.; original level regained immediately pumping stopped.

		Thickness. Ft.	Depth. Ft.
Made ground		5	5
[River Gravel] Ballast		6	11
[London] Hard blue clay		32	43
[Reading Beds, 61 ft.]	Mottled clay	3	46
	Dark blue clay	1	47
	Green sand and clay	2	49
	Grey sand (light-green)	2	51
	Dark green sand	9	60
	Green sand and clay	2	62
	Brown running sand	6	68
	Dark clay and sand	30	98
	Light-coloured clay and sand	2	100
	Sandy clay	4	104
[Upper Chalk.]	Chalk	25	129
	Chalk and flints	11	140

Some details above (Ordnance Datum and the effect of prolonged pumping) are from a communication by Messrs. Sands and Walker.

This well gives a good supply to the whole village, whereas previously (Dr. Thresh's Report of 1901, pp. 133, 134) the supply was from wells, many of doubtful character, and, in the locality of Chapel Street, from a gravely polluted brook. The outlying houses had shallow wells, and some used the brook above referred to.

Roxwell.

Ordnance Map 240, new ser. (Essex 42, SE., 43, SW., 51, NE., 52, NW.). Geologic Map 1, NE.

1. Greenditch Row, about a quarter of a mile north-east of Boyton Cross, on the eastern side of the road (opposite the houses). Dug 1870. Communicated by R. W. CHRISTY.

		Thickness. Ft.	Depth. Ft.
Soil	...	2	2
[Glacial Drift.]	White clay	20	22
	Blue clay, with much chalk, in large and small pieces	10	32
	Sand, with water, to gravel	8	40

2. Hill Farm. 1887.
R. W. CHRISTY, *Essex Naturalist*, No. 7, p. 150, No. 12, p. 280, and from a letter (Nov., 1887).
Shaft 60 ft., then bored.

Soil	...	2	70 ft.
[Glacial Drift.]	White Boulder Clay	28	
	Dark blue clay, with boulders	40	
	Gravel, with abundance of water.		

3. Little Boyton Hall.
Communicated by R. W. CHRISTY. 1888; but dug more than fifty years before.

Soil	...	3	
[Boulder Clay.]	White clay	25	44 ft.
	Blue clay, with much chalk, in large and small pieces; not bottomed	16	

4. Great Boyton Hall. From W. H. DALTON.

White Marl [Boulder Clay]	20	30 ft.
Sand and gravel, to black [Boulder] Clay	10	

5. Skreen's Park. Between the house and the stables. Well and boring. Communicated by H. O. N. SHAW.
231 ft. above Ordnance Datum.
Rest-level of water 122 ft. down. Excellent supply.
For an analysis of the water, see p. 432.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	[Boulder Clay.] Yellow clay and chalk stones	17	17
	[Boulder Clay.] Blue clay	12	29
	Ballast [gravel]	22	51
[London Clay.]	Yellow clay	2	53
	Blue clay, with rock [septaria] at 103 to 103½ and at 155 to 155¾	175	228
	Sandy clay, with rock at 235 to 236	19	247
	Blue clay	47	294
	Dead sand, with rock at 301 to 302, and at 305 to 306	25	319
[Lower London Tertiaries.]	Sand	8	327
	Clay and shells	7	334
	Green sand	3	337
	Coloured sand	19	356
	Grey sand	60	416
	Brown sand	1	417
	Dark green sand	1	418
	Grey sand	4	422
	Flints	2	424
[Upper Chalk]	Flints and chalk	34	458

A public well was sunk since 1900, at Boyton Cross; but a few people continued to use the brook (see p. 8) rather than fetch water from this.

Roydon.

Ordnance Maps 240 and 239, new ser. (Essex 40, SE.). Geologic Maps 47 and 1, NW.

1. Mr. E. A. Barclay's. 1889.
Made and communicated by Messrs. Le Grand and Sutcliff.
Water-level 26 ft. down.

		Thickness. Ft.	Depth. Ft.
Pit [the rest bored] ...		—	5
[London Clay.]	Sandy clay ...	7	12
	Blue sand ...	2	14
[Reading Beds, 50 ft.]	Hard mottled clay ...	18	32
	Sand and pebbles ...	18	50
	Blowing sand ...	14	64
[Upper] Chalk and flints ...		56	120

2. Temple Farm. 1888.
Made and communicated by Mr. G. Ingold.
Shaft 20 ft., the rest bored. Water from 18 to 20 ft. down.

Gravel ...	5	41 ft.
London Clay, with veins of black sand at 18 to 20 ft.	20	
[Reading Beds.] Strong clay, with blue and red veins	16	

3. Roydon Hamlet. Old House Farm, near Brickworks.
Sunk and communicated by Mr. G. Ingold.
Dug throughout. Strong spring from the gravel.

[Glacial Drift.]	Blue [Boulder] clay, with stones. Some gravel from 30 to 40 ft. down ...	63	77 ft.
	Yellow loam ...	3	
	Pebbly gravel and sharp sand ...	11	

4. Trial-bore, north-westward of Eastend. For the proposed South Essex Water Board. 1900.
Communicated by Messrs. Rofe. Made by Mr. Featherby.
111·3 ft. above Ordnance Datum.
Tubed (May, 1900) to 61½ ft.

		Thickness. Ft.	Depth. Ft.
Soil ...		2	2
[Alluvium.]	Stiff brown clay...	2	4
	White shelly debris ...	1	5
	Black peat (bog) ...	4	9
[? All Glacial Drift.]	Very coarse gravel ...	12	21
	Gravel ...	16	37
	Sand and gravel ...	5	42
	Hard massive flints ...	2	44
[Upper Chalk] Hard white chalk and flints		46	90

Another account adds 11 ft.
For an analysis of the water, see p. 432.

5. Netherhall. Trial-boring for the proposed South Essex Water Board. 1900. South-south-east of Netherhall.
Communicated by Messrs. Rofe.
93·08 ft. above Ordnance Datum.
Water-level 1 ft. 8 in. down (1900).

Roydon, cont.

		Thickness. Ft.	Depth. Ft.
Soil ...		$2\frac{1}{2}$	$2\frac{1}{2}$
[River] Gravel ...		8	$10\frac{1}{2}$
[? Reading Beds]	Clay (mixed) ...	3	$13\frac{1}{2}$
	Sand ...	21	$34\frac{1}{2}$
	White sand ...	$6\frac{1}{2}$	41
[Upper] Chalk and flints ...		123	164

This is suggestive of an error in the old geologic map (1, NW.), where the site is shown as at the junction of the gravel and the London Clay.

For analysis of the water, see p. 422.

Rushley, see **Great Wakering.**

Saffron Walden.

Ordnance Maps 205, 222, new ser. (Essex 3, SW., 9, NW., NE., SW.). Geologic Map 47.

1. Byrd's Farm, north-east of the town. 1875.
Made and communicated by Mr. G. INGOLD.
Water 164 ft. down.

		Thickness. Ft.	Depth. Ft,
[Boulder Clay.]	Blue Clay ...	36	36
	Brown Clay ...	8	44
	Clay and Chalk ...	2	46
Chalk ...		124	170

2. Westley Farm, north of the town. 1889.
Made and communicated by Mr. G. INGOLD.
Shaft throughout. Water 163 ft. down.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Blue Boulder Clay ...	35	35
	Clayey gravel ...	about 10	45
Chalk, with layers of hard rock, 2 to 5 ft. thick ...		123	168

3. Waterworks. Deep boring of 1836.

A history of the deep boring, from a letter by Mr. JABEZ GIBSON, was printed in 1878.[1] As the work was done on his initiative, and at his expense, it is well to quote therefrom. He says (writing some time after 1830) that "the wells in general are not abundantly supplied with water, yet sufficiently so in most seasons for general purposes; but the last year and the previous one proving so dry, many of the Wells were obliged to be deepened in order to obtain a better supply." This led him to wish that the experiment of boring should be tried, and failing to get help from others, he made the trial himself, employing S. Purkiss on the bores.

"The work was commenced . . . by sinking a Well or Shaft about 20 feet deep, which brought us to the upper land spring. . . The first 10 feet was Alluvial Gravel, then came the Upper Chalk, with flints, but of the latter minerals we came upon very few. After boring about 50 feet we reached a very hard substance, which proved to be a bed of 'inferior Oolite' of about 4 feet in thickness, after which the Chalk again made its appearance . . to the depth of 267 (? 277) feet, when a very fine spring of water was reached, lying in a bed of fine sand of about 7 feet in thickness. This spring has yielded 80 gallons of water per minute upon being pumped for three days and nights, without at all lowering the spring." A footnote, apparently by Mr. C. LONG, adds that pumping has gone on since 1862 at the rate of 166 gallons a minute, without lowering the water below a given point (not stated). Mr. GIBSON continues, "The water has apparently no connexion with the land springs, as at times it stands nearly 2 feet higher than they are, and when these arise

[1] *Proc. Norwich Geol. Soc.*, Part i, pp. 28-30.

Saffron Walden, cont.

after a wet time, they are the highest without affecting the main spring, which uniformly stands about 17 feet from the surface; indeed . . . it shows upon analysis that it is not the same water, being softer, and containing more iron." The boring was continued, in the hope apparently of getting water to rise to the surface, "when, after the Spring the Chalk Marle was found, and which continued to the depth of 1,013 feet 4 inches."

Another account, varying slightly, was given in the *Essex Literary Journal*, 15 Feb., 1839. This makes the depth, through the Chalk, to the spring, 275 ft.; the yield of the spring about 40 gallons a minute; and the total depth 1,004 ft. 4 in. This version was reproduced in the Memoir on Sheet 47, which was published before the 'Extract of a letter' from Mr. GIBSON in *Proc. Norwich Geol. Soc.*

The section is now given, according to Mr. GIBSON, with such explanations or additions as are needful:—

	Thickness. Ft.	Depth. Ft.
Drift. Gravel	10	10
Chalk, with few flints (Upper Chalk)	50	60
Hard rock (? Chalk-rock)	4	64
(Middle) Chalk	213	277
Fine sand (? can this be the Belemnite Marl) ...	7	284
Chalk Marl (? Lower Chalk, Gault, and perhaps other formations)	729	1,013

The newspaper-version above noted adds that the so-called Chalk Marl contained many shells with pyrites, but yielded no water, and that the "foreman, John Bell, did not during ten months quit the experiment for a single hour."

Dr. J. MITCHELL'S MSS. (in Libr. Geol. Soc.) says "Chalk 250 to 300 feet, with blue clay below," vol. ii, p. 102; but in vol. v, p. 67, we are told, "Chalk has been penetrated at Saffron Walden, and found there to be about 500 feet in thickness."

A note of W. H. PENNING says:—The well-borer told me, in 1870, that the only spring reached was in green sand, about 300 ft. down; that there was a bed of pipe-clay, 200 ft. thick, 400 ft. down; and that there was blue clay at the bottom of the bore.

These notes of clay or sand somewhere from 250 to 300 ft. down seem to agree with the entry of Belemnite Marl in the section above.

In March, 1900, Mr. DICKINSON said that the water-level varied from 151 to 157 ft. above Ordnance Datum, and that the yield was 90,000 gallons a day. He speaks of defective lining tubes and of a recommendation to sink a new well.

For an analysis of the water, see p. 433.

4. Waterworks. Newer well. 1900.
Made by Messrs. LE GRAND and SUTCLIFF.
Communicated by H. G. FEATHERBY.
170·24 ft. above Ordnance Datum.

Rest-water-level, March, 1900, 14 ft. 10 in. down. Pumping 10,000 gallons an hour reduces the level to $23\frac{1}{4}$ ft. down, and pumping 18,000 reduces it to $37\frac{1}{4}$. The normal rest-level is recovered in five minutes.

		Thickness. Ft.	Dept. Ft.
Made ground	... ...	9	9
[?Upper and Middle Chalk.]	Chalk and flints ...	26	35
	Flints	$\frac{1}{2}$	$35\frac{1}{2}$
	Chalk	$19\frac{1}{2}$	55
	Rock-chalk	3	58
	Soft chalk with few flints	167	225
	Very soft chalk	$19\frac{1}{2}$	$244\frac{1}{2}$
	Firm chalk	$80\frac{1}{2}$	325
	Chalk and flints ...	20	345
	Hard chalk	5	350

Saffron Walden, cont.

The following information is from the Water Works Directory, 1911:—The works were established in 1862 and purchased by the local authority in 1878. The population supplied is 6,300. The district of supply is Saffron Walden and the hamlet of Seward's End (to the east). The yearly supply is about 42,465,750 gallons; the daily consumption per head, domestic 14 gallons, trade 9. The maximum day's supply was 153,303 gallons, in June, 1910.

The water is softened (1912). For an analysis of the water, see p. 433.

According to Dr. THRESH's Report of 1901, p. 142, in 1897 the hamlet of Sewards (Sewers) End (eastward of the town) was too high for service from the waterworks. A shallow well was dug and a pump fixed; but it failed in the dry season. The alternative supply was from ponds. The supply is now pumped up from the waterworks into a small tower in the hamlet, holding 5,000 gallons.

St. Lawrence.

Ordnance Map 241, new ser. (Essex 55, SW., and SE.). Geologic Map 2.

According to Dr. THRESH's Report of 1901, p. 111, the houses were very scattered, and water was got from shallow wells and from ditches.

St. Osyth.

Ordnance Map 242, new ser. (Essex 38, SW., 47 NE., 48, NW.). Geologic Map 48, SW.

Mr. Newcomb's. Mill Street. Near Mill and near Creek at bottom of village-street. Has been in use for many years (1910).
Communicated by Dr. COOK.
Between 15 and 45 ft. above Ordnance Datum.
Water-level $19\frac{1}{2}$ ft. down (1910).

Sunk (4 ft. diameter) 19 ft. 10 in., the rest a 3 or 4-in. boring. Depth 158 ft., said to end in Chalk.

When cleaned out in 1909, Mr. Newcomb, the owner, found that the water rose in the bore-tube at about 1 in. per hour.

For analysis of the water, see p. 433.

According to Dr. THRESH's Report of 1901, p. 128, the parish had its supply from shallow wells, except for the one house above noted.

Saling, see **Bardfield** and **Great Saling.**
Sampford, see **Great** or **Old** and **Little Sampford.**

Sandon.

Ordnance Map 241, new ser. (Essex 53, NW., SW.). Geologic Map 1, NE.

Dr. THRESH. Report on the Water Supply of Essex, 1901, p. 104. Butts Green and Howe Green are supplied from Danbury (see p. 76). Near the church were two public lamps, one over a shallow well, the other over a small reservoir, fed by a spring piped from a short distance. A few houses on the outskirts had no proper supply. Some cottages, however, beyond reach of the water-mains, got a supply from springs, E. and ENE. of the village, 1913.

Sewardstone, see **Waltham Abbey.**
Shalford, see **Panfield.**

Sheering.

Ordnance Map 240, new ser. (Essex 31, SE., 41, NE.). Geologic Map 47.

1. Coffee Tavern.
Sunk and communicated by Mr. G. INGOLD.
Shaft. Water rose 14 ft. from the bottom.
White and blue Boulder Clay 43 ft.

Sheering, cont.

2, 3. Wells near Gladwyns: 2, a little south of the house (shaft); 3, at the lodge, a little north (shaft 43 ft. bored 8). 1890.
Made and communicated by Mr. G. INGOLD.

Water in 2 burst up suddenly from the bottom and rose to within $27\frac{1}{2}$ ft. of the surface; in 3 it came in very slowly from the bottom. The water probably comes from gravel below the Boulder Clay.

		(2)	(3)	Depth.
Soil	...	3	2	3 to 2
[Boulder Clay.]	White clay	6	6	8 to 9
	Brown clay	15	15	24 to 23
	Blue clay	17	28	41 to 51

4. Mr. Mann's Cottages.
Made and communicated by Mr. G. INGOLD. 1894.

Shaft throughout. Water rose to within $28\frac{1}{4}$ ft. of the surface. **Large quantities** of air (gas) bubbled up through the water for several weeks. **Analysis** showed that it contained 71·95 vols. of carbonic acid in 10,000.

Soil	...	2	$36\frac{1}{2}$ ft.
[Boulder Clay.]	White clay ...	3	
	Brown clay ...	$31\frac{1}{2}$	

5. Mr. Silk's House.
Made and communicated by Mr. G. INGOLD.
Shaft 36 ft., the rest bored.
Water from sandy veins in the clay.

Soil	...	3	43 ft.
[Boulder Clay.]	Brown clay ...	17	
	Blue clay ...	23	

6. Old Lane. 1884.
Made and communicated by Mr. G. INGOLD.
Shaft $72\frac{1}{2}$ ft., bored $2\frac{1}{2}$. Water-level $70\frac{1}{2}$ ft. down.

		Thickness. Ft.	Depth. Ft.
[? All Drift.]	Brown clay ...	21	21
	Loam ...	3	24
	Sand ...	1	25
	Gravel ...	2	27
	Blue clay, to sand with water...	48	75

Shelley.

Ordnance Map 240, new ser. (Essex 51, NW. and SW.).
Geologic Map 1, NW.
Cottages near the Red Cow Inn.
Chelmsford Chronicle, March 22, 1878.

Dark marl, bedded with much small chalk and shells, about 30 ft.
Hard rock of cemented gravel.
Fine mud, bored through a short distance to water [? London Clay].

Shellow Bowells.

Ordnance Map 240, new ser. (Essex 51, NE.). Geologic Maps 1, NW. and NE.
Shellow Cross. East of village. Old well.
Information from Mr. PURKIS to W. H. DALTON.

Glacial Drift	Boulder Clay ...	5	65 ft.
	Gravel ...	10	

Shenfield.

Ordnance Map 257, new ser. (Essex 59, SE., 67, NE.).
Geologic Maps 1, NW. and NE.

Dr. THRESH. Report on the Water Supply of Essex, 1901, p. 85.

There was one public well, but most houses were connected with the South Essex Waterworks.

Shoeburyness, including North and South Shoebury of the older map.

Ordnance Map 258, new ser. (Essex 79, SW.). Geologic Map 2.

1. Waterworks. About a mile north of the town.

Made and communicated by R. D. BATCHELOR, 1895 (and from J. MANSERGH).

About 35 ft. above Ordnance Datum.

Iron cylinders ($6\frac{1}{2}$ ft. diameter) to 75 ft., and then brick shaft to 170 ft., the rest bored.

Water-level 76 ft. down, lowered to $146\frac{1}{4}$ after 48 hours test-pumping.

According to Dr. THRESH (Report of 1901, p. 76) the rest-level was 85 ft. down and the original yield was 5,000 gallons an hour. In April, 1896, the rest-level was 97 ft. down. It was 110 in October, 1899. In that month pumping at the rate of 10,000 gallons an hour for from $4\frac{1}{2}$ to 8 hours a day sufficed for the town. The yield was estimated at 120,000 gallons a day.

		Thickness. Ft.	ins.	Depth. Ft.	ins.
Mould ...	...	2	0	2	0
[River Drift, 20 ft.]	Brickearth	4	0	6	0
	Gravel, with water	1	6	7	6
	Gravel and sand	14	6	22	0
[London Clay, 396 ft.]	Brown clay	3	6	25	6
	Blue clay...	3	0	28	6
	London Clay	21	6	50	0
	Sandy clay, with a little peat, very soft. Water (about 1,000 to 1,200 gallons an hour)	2	6	52	6
	Sand	8	6	61	0
	Gravel	1	1	62	1
	Clay	4	8	66	9
	London Clay	351	3	418	0
[Oldhaven Beds, 37 ft.]	Loamy sand, with water	17	0	435	0
	Sand	11	0	446	0
	Greenish dead sand and a few pebbles	9	0	455	0
[Woolwich Beds, 20 ft.]	Black sand, dead and sticky	5	0	460	0
	Dark sand, almost black	10	0	470	0
	Dark peaty sand	3	0	473	0
	Dark clean sand	2	0	475	0

Judging by the section of the garrison-well, it is possible that the River Drift should be taken down to 62 ft., in which case the clays between that depth and 22 ft. may represent the brickearth of Grays, etc., of the existence of which a trace was found in a railway-cutting near Rochford in 1887 (see 'Geology of London and of Part of the Thames Valley,' vol. i, p. 422).[1]

The water was faintly turbid, probably from a trace of iron. For analyses, see pp. 434, 435.

The Report of the Medical Officer for 1912 says that in 1911 the water-level fell so much that sufficient water for the supply of the town could not be raised without also raising a considerable amount of fine sand, which seriously affected the pumps. In 1912 new pumps were put in, and water was got without sand. The supply is about 35,000 to 40,000 gallons a day.

According to Dr. THRESH'S Report of 1901, North Shoebury was then supplied by shallow wells, yielding water of questionable character. The supply now comes from the waterworks.

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[1] This suggestion has been shown to be right (1915.) Freshwater shells (amongst them *Corbicula fluminalis* and pieces of a small *Cardium* have been found in the clay and sandy clay, and G. BARROW regards these beds as filling a channel.

Shoeburyness, cont.

2. Made by T. Docwra. 1863.

Presumably a trial-boring made for the War Office. Messrs. Docwra cannot find a record of the site.

		Thickness. Ft.	Depth. Ft.
Mould	...	1	1
[River Drift.]	Sand and gravel	$13\frac{1}{2}$	$14\frac{1}{2}$
	Yellow clay	2	$16\frac{1}{2}$
	Blue clay and brick-earth	12	$28\frac{1}{2}$
	Blue and yellow clay	2	$30\frac{1}{2}$
	Charred wood (black peat)	$\frac{1}{2}$	31
	Light-coloured sandy mud, with water	18	49
	Coarse gravel, with water	$4\frac{1}{2}$	$53\frac{1}{2}$

3. For the supply of Shoeburyness Garrison. Less than half a mile north-eastward of St. Andrew's Church. 1886-1889.

Communicated by Colonel E. Raban, R.E. (and from specimens, in these brackets).

About 23 ft. above Ordnance Datum. (20·38, Col. Boyd. 1910.)

Cylinders to 80 ft.; then shaft to 170 (enlarged from 115 downward); the rest bored. After piercing the clay (434 ft.) it was found that this was closing round the lining-tube, so that it could not be driven further; a timbered shaft, 4 ft. square, was then made round the tube to the depth of 386 ft.

The Chalk was so soft, for a great depth, that the tube had to be carried down to the depth of 844 ft.

Water was met with at the base of the London Clay, at 434 ft. (September, 1887), and still more at 456 ft., when it gave much trouble and was difficult to keep down, the water rising to 39 ft. below the ground. While boring between 844 and 896 ft. water began to rise rapidly, to 41 ft. from the surface (October, 1888), but on testing the yield the well was pumped dry in $6\frac{1}{2}$ hours and took several days to fill again. After further boring the water continued to rise, and at 916 ft. stood 23 ft. from the surface (November 7, 1888), but a second pumping-test gave no better result than the first. After this the water-level fell somewhat, to 41 ft. on July 2, 1889, at 1,048 ft.

Another record of water-level, from Lieutenant R. P. Robinson, R.E., gives the following figures, in depths from the surface, approximately:— 1887, Sept. 20, over 38 ft.; 1888, Nov. 8, 144 ft.; Nov. 10, 124 ft.; Nov. 16, 163 ft.; Nov. 28, 30 ft.; 1889, June, 40 ft.; July 1, 33 ft.; Nov. 12, 80 ft. The great variations are probably owing to pumping that was going on.

At 473 ft. sand blew 200 ft. up the tube, and at 476 ft. it filled 100 ft. of the tube. Since leaving the bottom of the tube it has come in occasionally.

		Thickness. Ft.	Depth. Ft.
Soil	...	3	3
[River Drift, 51 ft.]	Brown sand and gravel	8	11
	Brick-earth	12	23
	Stiff clay (light-brown at 32)	15	38
	Sand, with water (clayey sand at 42)	10	48
	Ballast (gravel, of flint pebbles and flints)	6	54
London Clay, with bed of large clay-stones at 162, and clay-stones at 205 (sandy at the base)		380	434
[Blackheath Beds, 26 ft.?]	Sand, shells and pebbles, with water (hard clay with green grains; pale greenish sand; pebbles)	14	448
	Clay (brownish-grey) and black pebbles	12	460
[Woolwich Beds, 21 ft.?]	Black peat (lignity clay)	2	462
	Clean (sharp grey) sand	10	472
	Peat (lignite and lignity clay)	5	477
	(Coarse grey) sand (or grit, with wee pebbles of quartz)	2	479
	Peat (hard lignite)	2	481

Shoeburyness, cont.

		Thickness. Ft.	Depth. Ft.
[Thanet Beds, 106 ft.?]	(Brownish-grey, fine, sharp) sand ...	27	508
	Clay (pale grey, and more or less sandy at 545, 547, 549, 550, 555, 560) ...	54	562
	Sandy clay, with water	13	575
	Clay	11	586
	Green sand, with water (green-coated flints in sandy clay with green grains)	1	587
[Upper Chalk, 309 ft.]	Soft chalk; clayey at 609	193	780
	Soft chalk, with layers of flints at about 4 feet intervals	70	850
	Hard chalk, with flints (specially marked at 869 and 875)	46	896
[? Middle Chalk, 144 ft.]	Very hard grey chalk	50	946
	Soft chalk	2	948
	Chalk	4	952
	Hard chalk	16½	968½
	Chalk and sand	1½	970
	Loamy sand	1	971
	Chalk and sand	4	975
	Chalk	14	989
	Hard grey chalk	2	991
	Chalk	11	1002
	Chalk, mixed with loose sand in the lower part	30	1032
	Hard chalk	1	1033
	Chalk	2	1035
	Hard chalk	5	1040
[? Lower Chalk.]	Chalk	6	1046
	Chalk, with loose sand	2	1048

The divisions of the Lower London Tertiaries are not clearly marked. Perhaps the lower bed classed with the Blackheath Beds may belong in part to the Woolwich Beds; and the same may be the case with the top sand classed with the Thanet Beds. The divisions of the Chalk are still more doubtful.

The bore-pipes are said to have been cut, so as to get water from the sands of the Lower London Tertiaries.

Colonel Raban wrote that on reaching the water-bearing beds beneath the London Clay (which gave much trouble), from 434 to 460 ft. down, the water-level in the War Department well at Sheerness fell 17 ft.

For analyses of the water, see pp. 434, 435.

Another well, made for the garrison-supply later, was apparently all bored. Lined with 18-in. tubes to 74 ft., with 16-in. tubes from the top to 421 ft., and with 10-in. tubes 15 ft. into the Chalk.

The water-level was 180 ft. down (or 177 below Ordnance Datum) and the suction 340 ft. down (or 317 below Ordnance Datum). There is a horsehair screen from 381 to 517 ft. down, to keep out sand, though a little still comes through.

The section is the same as the above, with mere verbal differences. Water is recorded as occurring in the 'pale sand' from 38 to 48 ft. down. The flint-pebbles are described as small. The total depth seems to be 604 ft.

Shopland.

Ordnance Map 258, new ser., but not marked thereon (Essex 78, NE.).

Geologic Maps 1, NE., and 2.

Dr. Thresh. Report on the Water Supply of Essex, 1901, p. 79.

Population 58. No village. Each farm has its own shallow well. Water of inferior quality.

Now in the area of the Southend Water Co.

Sible Hedingham.

Ordnance Map 223, new ser. (Essex 11, SW., SE., 16, NW., NE.). Geologic Map 47.

According to Dr. THRESH's Report on the Water Supply of Essex, 1901, p. 121, there were then four public wells, one 70 ft. deep, and six public springs. In outlying parts water was got from ponds and ditches. His Report of 1905, p. 64, says that a public well, 35 ft. deep, supplied most of the inhabitants, a few houses were supplied from springs, and about 20 per cent. from private wells, 15 to 50 ft. deep. (Quality said to be doubtful.)

Silvertown, see **North Woolwich,** p. 321.

South Benfleet.

Ordnance Map 258, new ser. (Essex 77). Geologic Map 1, SE.

1. Public well. For Rochford Rural District Council. Taken over by Southend Water Co. in 1913. No. 26, known as the Benfleet well. ½ mile west of railway-station. 1900.
Communicated by E. C. BILHAM.

Dr. THRESH's Report on the Water Supply of the County of Essex, p. 30 (1901), gives a somewhat different account.

29½ ft. above Ordnance Datum.

An 8-ft. well to 233 ft., then a 15-in. tube to 423·64, then a 12-in. perforated tube inside the 15-in. and reaching to 561·07. The rest unlined 12-in. boring.

Water-level 80 ft. down (Oct., 1900, when unfinished). Highest level (from 1913?) 58½ ft. down. Lowest (pumping) 229½.

Yield 6,000 gallons an hour (Oct., 1900).

		Thickness. Ft.	Depth. Ft.
London Clay	... ...	309	309
[Lower London Tertiaries.]	Sand	42	351
	Hard clayey sand	110	461
[Upper] Chalk	... ...	181	642

For analysis of the water, see p. 435.

Previous to the making of the above well the inhabitants (575) got water from two private bored wells, which had practically failed shortly before.

2. Benfleet Marshes. Old well.
Information from Mr. PURKIS, the sinker, to W. H. DALTON.
To base of London Clay, 275 ft.

Southchurch, see **Southend.**

Southend.

By the extension of the borough Leigh, Prittlewell and Southchurch have been included.

Ordnance Map 258, new ser. (Essex 78). Geologic Maps 1, SE., 2.

1. Elton Laundry. 1911.
Boring made and communicated by Messrs. DUKE and OCKENDEN.

12-in. tubes to 164 ft.; 10-in. tubes, 143 to 307 ft.; 8-in. tubes, 296 to 411 ft.; 6-in. tubes, 400 to 496 ft.

Water found at 496 to 503 ft. Water-level 240 ft. down.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Brown clay	18	18
	Blue clay, 6 ins. of rock at 469 ft. ...	451	469
	Sandy clay	27	496
? Oldhaven Beds]	Sand and water	7	503

Southend, cont.

2. On the Green, Lower Southend. (Name not on the newer map. By the shore east of the pier.) About 1850.
Communicated by Mr. Scott, of the Royal Hotel.
Surface about high-water mark.

Sand and shingle [beach]		35	To sand and water, 475 ft.
Blue [London] Clay ...	about	440	

3. Another well near by, 380 ft.

4. According to Mr. Purkis a well at the Royal Hotel Mews reached the base of the London Clay at 370 ft.; but these figures would seem to be too low, as also is the case with the following (from the same authority, through W. H. Dalton).

5. Railway Station, Tilbury Line.

River gravel	15	395 ft.
London Clay	340	
Sand	40	

6. Well on the northern side of the high road, about opposite to where High Street runs into it.
Brickearth, 8 ft. Gravel, and then sand, 18 ft.

7. New Sewage Works. 1912.
Shallow wells. Water from gravel. For analysis, see p. 436.

8. Old well at Leigh.
From H. W. Bristow's Notes. Information from J. Darby.

[London Clay.]	Chocolate-coloured clay with cement-stones ...	40 ft.
	Blue clay ...	200 ,,
[? London Clay.]	Sand (water) ...	5 ,,
	Chocolate-coloured clay ...	?

9. Leigh Marshes. Old well.
Information from Mr. Purkis, the sinker, to W. H. Dalton.
To base of London Clay, 310 ft.

10. Prittlewell. Vicarage.
About 95 ft. above Ordnance Datum.
From Sir R. T. Thorne, of the Local Government Board.

Surface soil, brick-earth, gravel, and sand ...	over	40 ft.
London Clay ...	about	380 ,,
Lower London Tertiaries, ? depth.		

11. Old well at Southchurch.
Information got by W. H. Dalton from Mr. Purkis, well-sinker.
Water up to 36 ft. below the surface.

To base of London Clay ..	355	395 ft.
Sand	40	

12. Southend, or No. 1 Pumping-station of the Southend Water Co. Just north of railway and west of road nearly half a mile west of station (Tilbury line). Brought into use in 1865.
99·71 ft. above Ordnance Datum.
B. Latham, *Trans. Soc. Eng.* for 1864, p. 249, and later information.

Sunk 385 ft. ? Water rose to within 100 ft. of the surface in 1865, the water-level was at 185 in 1867, and in 1868 it rose to about 120.

Two shafts, communicating; with one boring. At one time (before 1876) much sand came up.

Southend, cont.

		Thickness. Ft.	Depth. Ft.
Soil ...		3	3
[London Clay, 414 ft.]	Yellow clay ...	30	33
	Blue clay...	384	417

To running sand [Woolwich or Oldhaven Beds].

A newer well (6 ft. diameter to 227 ft. and then $4\frac{1}{2}$ ft. to 379, and then a boring decreasing from 9 ins. to $2\frac{1}{2}$ ins. and lined to 604 ft.), a few yards from the above (which fell in), sunk and communicated by Messrs. T. Docwra & Sons, continues the section, as follows :—

	Thickness. Ft.	Depth. Ft.
Bored through the running sand, and through clay, sand, and pebbles [Lower London Tertiaries] ...	181	598
[Upper] Chalk...	302	900

For analyses of the water, see pp. 436, 437.

13. Waterworks. On the southern side of the Hadleigh Road, seven-eighths of a mile north-west of Leigh Church. 1896.

Taken over by the Southend Water Co. in 1907 (Leigh or No. 18 well).

Sunk and communicated by Mr. R. D. BATCHELOR. Some information from E. C. BILHAM, whose account differs slightly.

137 ft. 8 ins. above Ordnance Datum.

Shaft, 9 ft. diameter to 155 ft., then 8 ft. diameter to 293 ft. (? 342), the rest bored. 27-in. pipe for $377\frac{1}{4}$ ft., 26-in. unlined to 400 ft., 15-in. pipe to 440 ft., 12-in. (internal) tubes to 600 ft.

The water found in the sand 364 ft. down rose 100 ft. in the well. That found in the Chalk 570 ft. down made a rise of 8 ft. of water in the well. Water-level 173 ft. down on completion. Highest (since 1907) 172 ft. down. Lowest (pumping) 363 ft. Supply abundant, from the Chalk. About 250,000 gallons a day got.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Clay ...	17	17
	Black clay ...	20	37
	Clay with large boulders [septaria] ...	12	49
	Clay ...	34	83
	London clay ...	251	334
	London clay, with sand ...	25	359
[Blackheath Beds.]	Sand varying in colour ...	$6\frac{1}{2}$	$365\frac{1}{2}$
	Gravel [flint pebbles] and rock ...	$14\frac{1}{2}$	380
[? Woolwich Beds.]	Sand ...	40	420
	Clay and sand ...	20	440
[? Woolwich Beds, and Thanet Beds.]	Solid clay ...	15	455
	Clay and sand ...	43	498
	Clay ...	22	520
[Upper Chalk.]	Chalk and flints ...	64	584
	Chalk ...	16	600

The following particulars are from a letter (dated 29th June, 1905) by A. N. HIGGINS, in the *Leigh and Westcliff Chronicle* :—

When Leigh was a fishing village, the inhabitants got water from the Bay well, Lady Sparrow's well, and Dobin's well. These sources were more or less superficial and inadequate for the increasing population. Consequently the well above described was made. Pumping was begun in January, 1898, and by October the head of water had fallen 49 ft., to 225 ft. down (? rest-level). Pumping at the rate of 10,000 gallons an hour reduced the level to about 242 ft. Further shrinkage, however, took place, as follows, he suggests because of the deeper wells of the Southend Co. :—

Between 1899 and 1901 there was a shrinkage of about 10 ft. ; between 1901 and 1903 a further shrinkage of about 26 ft. ; from 1903 to 1904 a further shrinkage of about 33 ft. ; from 1904 to May, 1905, a further shrinkage of about $24\frac{1}{2}$ ft.

Mr. BAILEY-DENTON has said, from investigations made, it is clear that most of the water comes from the sands of the Lower London Tertiaries.

Water pumped from the bore-pipe (1914). For analyses, see p. 414.

Southend, cont.

14. For the Southend Waterworks. No. 2, known as the Prittlewell well. About a fifth of a mile nearly south-south-west from Prittlewell Church.
1882.
101½ ft. above Ordnance Datum.
Communicated by T. Hawksley and E. C. Bilham.

Shaft 376 ft. (of 10 ft. diameter to 300 ft., then reduced to 5 ft.); the rest bored and lined to 577 ft. with 19, 16 and 13-in. pipes. Unlined 12 ins. diameter to 876. Water from Thanet Sand. Water-level 143 ft. down. Highest recorded level 132 ft. 8 ins. down. Lowest (pumping) 376.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil	...	1	6	1	6
[River Drift, nearly 45 ft.]	Brick-earth	8	6	10	0
	White loam and sand	1	0	11	0
	Red sand, with a 3-in. layer of brown loam a foot down, and a 2-in. layer 2 ft. down	4	7	15	7
	Gravel and sand	4	8	20	3
	Yellow sand; junction with bed below showing a dip	26	0	46	3
[London Clay 362 ft.]	Yellow clay	2	0	48	3
	Clay (water rose on piercing this)	360	1	408	4
[Oldhaven Beds, Woolwich Beds, and Thanet Beds.]	Sands	162	6	570	10
	Green flints	0	6	571	4
[Upper] Chalk, 305 ft.	Chalk with flints	118	6	689	10
	Hard chalk without flints	35	0	724	10
	Soft chalk with flints	118	0	842	10
	Very hard chalk with flints	22	0	864	10
	Soft chalk with flints	11	7	876	5

This well is remarkable for the great thickness of sand and gravel above the London Clay, and for the thickness of the Lower London Tertiaries (the beds between the London Clay and the Chalk), in which it agrees with the Southend well, see p. 261. For analyses of the water, see p. 428.

15. Southchurch, or No. 9, Pumping-station of the Southend Water Co.
1901.
Communicated by E. C. Bilham.
83 ft. above Ordnance Datum.

Well 6 ft. in diameter to 439 ft., the rest bored. Lined with 24, 21, and 18-in. pipes to 624 ft.
Highest water-level 178 ft. down. Lowest level (pumping) 417·25 ft. down. Little if any water from the chalk.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil...	...	1	0	1	0
[River] Gravel	...	10	6	11	6
[London Clay.]	Yellow clay ...	1	0	12	6
	London Clay. Rotten and containing at 35 ft., sand seam, and a little water at 79 ft. 8 in. Beds of clay nodules [septaria] at 86, 102¾, 223¼, 267¼, and 281¼. Straggling clay nodules at 317¼ to 326¼. More nodules (? beds) at 343¼, and (very large) 358¼. Beds of nodules at 365½ and 370¼ ...	450	3	462	9

Southend, cont.

		Thickness. Ft.	In.	Depth. Ft.	In.
	Very hard sand	5	0	467	9
	Dark sand and shells ...	1	6	469	3
[Oldhaven Beds, Woolwich Beds and Thanet Beds, 156¾ ft.]	Green sand and pebbles ...	10	9	480	0
	Sand stone	1	0	481	0
	Dark sticky sand	19	5	500	5
	Live sand	2	11	503	4
	Sandy clay	24	8	528	0
	Sand and shells	3	0	531	0
	Sandy clay	10	6	541	6
	Sand and shells	4	0	545	6
	Sandy clay	6	0	551	6
	Hard sand and shells ...	1	3	552	9
	Sandy clay	16	6	569	3
	Hard sand	4	0	573	3
	Green sand	1	3	574	6
	Sandy clay	44	1	618	7
[Upper Chalk.]	Flints	0	6	619	1
	Chalk...	1	6	620	7
	Very soft chalk	4	0	624	7
	Chalk with odd flints, 18-in. tube sank by its own weight	8	0	632	7
	Harder chalk with odd flints	39	8	672	3
	Flint bed	0	4	672	7
	Chalk with odd flints ...	50	11	723	6
	Bed of flints	1	0	724	6
	Chalk and odd flints ...	24	0	748	6
	Flints	0	3	748	9
	Chalk...	12	0	760	9
	Hard chalk	4	6	765	3
	Softer chalk	6	3	771	6

For an analysis of the water, see p. 436.

For other pumping stations of the Southend Water Co., see **Billericay, Bowers Gifford, Downham, Eastwood, Fobbing, Great Wakering, Pitsea, Ramsden Bellhouse, South Benfleet, Thundersley, Vange,** and **Wickford.**

The following para. is from the Water Works Directory, 1911, p. 330:—

The works were established in 1870. The population supplied is 80,000. The towns and villages in the area supplied, besides the borough of Southend, are:—Barling, Basildon, Bowers Gifford, Downham, Dunton, Eastwood, Fobbing, Great Burstead, Great Wakering, Laindon, Langdon Hills, Lee Chapel, Little Burstead, Little Wakering, Mountnessing, Nevenden, North Benfleet, North Shoebury, Pitsea, Ramsden Bellhouse, Ramsden Crays, Shopland, South Shoebury, Sutton, Thundersley, Vange, and Wickford.

The Company has purchased the works of the Rochford Rural District, and therefore extended its mains, the population supplied in 1914 being about 100,000.

South Essex Waterworks Co.

Water Works Directory, 1911, p. 331.

Works established, 1861. Area supplied, the parishes of Aveley, Barking, Billericay, Brentwood, Chadwell, Corringham, Cranham, Dagenham, East Tilbury, Grays, Great Warley, Havering-atte-Bower, Hornchurch, Horndon-on-the-hill, Hutton, Ilford, Little Thurrock, Mucking, North Ockendon, Orsett, Purfleet, Rainham, Romford, Shenfield, South Ockendon, South Weald, Stanford-le-Hope, Upminster, Wennington, West Thurrock, and West Tilbury. The population of the area supplied was 188,000, and the yearly supply was 1,534,000,000 gallons. There must have been an increase since.

The pumping-stations are named Dagenham (see Rainham), Grays, Ilford, Linford (see Muckingford), Roding (see Ilford), Romford.

South Fambridge, see also under Fambridge.

Ordnance Map 258, new ser., but not marked thereon (Essex 70, NW.).
Geologic Map 1, NE.

Ironworks, 50 yds. east of the post-office.
Information from WIMSHURST, HOLLICK and Co.
Sunk 6 ft., bored 313 ft. A 5-in. boring. Pump-barrel 80 ft. down
No details, but thought to end in sand and clay.
These ironworks have been closed.
For analysis of the water, see p. 438.

According to Dr. THRESH's Report of 1901, p. 79, a good and abundant supply for the parish was got from the well at the ironworks. In 1905 nearly the whole population was supplied therefrom.

South Hanningfield.

Ordnance Map 258, new ser. (Essex 61, SW.). Geologic Map 1, NE.

1. Brockley Hill. (? Brockhill of new map, Brockwell Hill of old map.)
A shallow well in Boulder Clay.
For analysis of the water, see p. 439.

2. Bearmain's. West of the house and south-westward of the Church. 1900.
Made and communicated by Mr. J. W. TITT.
A boring 600 ft. deep. Chalk not reached. No water.

According to Dr. THRESH's Report of 1905, pp. 48, 49, the place is not well supplied. Many houses are too high for the Danbury supply; many are supplied from a spring at the Windmill Inn; several use the roadside-brook (? ditch) and a few rain-water.

Southminster.

Ordnance Maps 241, 242, 258, 259, new ser. (Essex 63, 64, SW.).
Geologic Map 2.

Dr. GREENHOW, in a Report of 1860, says:—'The water is taken from springs and wells.' There is now a public supply, from springs at Asheldham (see p. 73).

Deal Hall (Map 259). On the marsh near the southern boundary of the parish, about a mile north of the Crouch. New well. 1906.
No details available, but said to end in Thanet Sand.
For an analysis of the water, see p. 439.

South Ockenden.

Ordnance Map 257, new ser. (Essex 75, SE., chiefly). Geologic Map 1, SW.

According to Dr. THRESH's Report of 1905, p. 28, 95 per cent. of the supply then came from the South Essex Co., and the rest from private wells, about 25 ft. deep.

South Shoebury, see Shoeburyness.

South Weald.

Ordnance Map 257, new ser. (Essex 59, SW., 67, NW.). Geologic Map 1, NW., and London District, Sheet 2.

According to Dr. THRESH's Report on the Water Supply of Essex, 1901, p. 85. The more populous part was supplied by the South Essex Company. The Asylum has its own well, and the rest of the inhabitants used private shallow wells, a few of which failed in summer.

1. PRESTWICH, *Quart. Journ. Geol. Soc.*, vol. x, p. 404. 2. Dr. J. MITCHELL's MSS., vol. iii, p. 75.

1. Brook Street. To the bottom of the London Clay about 400 ft.

2. Brook Street. Water got after passing through about 340 ft. of clay, and rose to within 100 ft. of the surface.

See also under **Brentwood**, pp. 104, 105.

Springfield, see **Chelmsford.**

Stambourne.

Ordnance Maps 206, 223, new ser. (Essex 10, NE., 11, NW.).
Geologic Map 47.

According to Dr. THRESH's Report of 1901, p. 121, the chief supply was from a public pump (well) and from a public spring, which had been protected and provided with a pump. Outlying cottages depended on ponds and ditches.

According to his Report of 1905, p. 65, the two public pumps supplied about a third of the population, and there were many private wells, from 34 to 120 ft. deep. Ditches, etc., still used.

Stambridge (should have gone under **Little Stambridge,** p. 217).

Ordnance Map 258, new ser. (Essex 70, SE.). Geologic Map 1, SE.

Stambridge Mill.
From G. R. STRACHAN.
Well 60 ft. Boring 350. Total 410.

Stanford-le-Hope.

Ordnance Maps 257, 258, new ser. (Essex 76, SE., 84, NW. and NE.)
Geologic Map 1, SE.

According to Dr. THRESH's Report of 1901, p. 71, the South Essex Company supplied a few houses, the rest depended on wells, many impure; since then a large number of houses have taken the Company's water. In 1905 only 5 per cent. depended on shallow wells, from 8 to 40 ft. deep.

1. Broad Hope Farm, a mile south of east from the church. 1895.
Bored and communicated by Mr. R. D. BATCHELOR.
Dug well 22 ft., the rest bored. Tubes left 3 ft. up in the well.
Water-level 31 ft. down, lowered 7 ft. after pumping all day.
Supply tested to 720 gallons an hour.

		Thickness. Ft.	ins.	Depth. Ft.	ins.
Old well [Gravel and London Clay ?], the rest bored		—		22	0
[London Clay.]	Clay	45	0	67	0
	Clay and sand	5	0	72	0
[? Blackheath Beds, 49⅔ ft.]	Sand	5	0	77	0
	Sand and black [flint] pebbles	5	0	82	0
	Thanet sand and black [flint] pebbles	5	6	87	6
	Sand, etc.	8	6	96	0
	Gravel [flint pebbles] and sand	10	8	106	8
	Gravel [flint pebbles]	5	0	111	8
	Sand	2	0	113	8
	Sand and gravel [flint pebbles]	8	0	121	8
[Woolwich Beds, 33½ ft.]	Dark sand and clay	6	0	127	8
	Dark sand	12	6	140	2
	Sand and gravel [flint pebbles]	15	0	155	2
[Thanet Sand, 64 ft.]	Dark sand	12	0	167	2
	Sand	34	0	201	2
	Dark sand	18	0	219	2
[Upper] Chalk		55	10	275	0

This section seems to show the Oldhaven or Blackheath Beds in unexpected force greatly at the expense of the Woolwich Beds.

For analysis of the water, see p. 440.

2-5. Four old Wells.
Information from Mr. HILLS, well-sinker (from H. W. BRISTOW's Notes).

2. Dent's, opposite the King's Head, a sort of white sand, 15 or 16 ft.

3. Hassenbroke (north of village). Pale brownish sand, 10 or 12 ft., to blue quicksand.

Stanford-le-Hope, cont.

4. Old Jenkins (west of village). Place not marked on the newer map. A little eastward of New Jenkins. ?destroyed. Bluish quicksand, 10 or 12 ft.

5. Polters (north of village).

[London Clay.]	Strong clay	8 or 10 ft.
	Bluish clay, to blue [wet] sand	7 to 8 ft.

6. Mr. Thomas Sullings.
Made and communicated by Messrs. Isler and Co.
Lined with 65 ft. of 3-in. tubes from 3 ft. down.
Water-level 36 ft. down. Supply 360 gallons an hour.

Dug well (the rest bored) ...	40	69 ft.
Blue clay	23	
Black ballast [gravel] ...	2	
Black gravel	4	

7. Kynochtown. Messrs. Kynoch. By a mistake as to the site wells 7, 8, 9 have been misplaced. They are in Corringham parish, by Shellhaven.
Made and communicated by Messrs. Isler and Co.
Lined with 56 ft. of tubes of 8½ in. diameter, 4 ft. down, the bottom 5 ft. perforated.
Water-level 6 ft. down. Supply 8,000 gallons an hour.

[Alluvium.]	Blue clay	35	61½ ft.
[River Drift.]	Running sand ...	21	
	Ballast [gravel] ...	5½	

8. Another well at Messrs. Kynoch's. 1900.
An 8½-in. bore. Yield 8,000 gallons an hour.
Bottom of well filled with broken bricks, to 69 ft. 3 in.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Ground-level (? made ground) Stiff brown clay	5½	5½
	Spotted blue clay	12½	18
	Decayed vegetation or peat	2½	20½
	Soft blue mud	29½	50
	Stiff clay and small stones	1¾	51¾
[River Drift ?]	Large stones (flints)	1¾	53½
	Coarse sand and small stones	12	65½
	Coarse sand and shingle	7	72½
	Sand and broken shells	1	73½

9. Another well at Messrs. Kynoch's. 1900.
Made and communicated by Messrs. Isler and Co.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Stiff brown clay...	5	5
	Spotted blue clay	20	25
	Blue clay and sand	23	48
[? River Drift.]	Sand and small ballast [gravel] ...	5	53
	Coarse sand	5	58
	Coarse sand and ballast [gravel] ...	12	70
	Running sand and ballast	10	80
	Fine sand and small stones	2	82
	Sand and rough ballast [gravel] ...	5½	87½
	Sand and flintstones	1¼	88¾
	Fine shingle	1¾	90½
[? London Clay.]	Hard blue clay and stones	7	97½

These three sections (7-9) show a considerable thickness of Alluvium, and the last of River Drift also.

Stanford-le-Hope, cont.

10. Brewery. Close to railway-station.
About 29 ft. above Ordnance Datum.
Information from S. W. SQUIER to W. H. DALTON.

Found Chalk at a little over 100 ft. and got an abundant supply. For an analysis of the water, presumably from this well, see p. 440.

Stanford Rivers.

Ordnance Map 240 (Essex 50, SE., 51, SW., 58, NE., 59, NW.).
Geologic Map 1, NW.

1. Rectory.
Communicated by the Rev. Mr. ROLLESTON.
Sunk during the Rectorship of Dr. DOWDESWELL, 1802-1842.
216 ft. above Ordnance Datum.
Water-level 135 ft. down (1900). Yield abundant (1900).
365 ft. deep. Said to be into Chalk (Dr. THRESH thinks not).
For analysis of the water, see p. 440.

2, 3, 4. Three old wells.
Information from Mr. ROLFE, the sinker, to W. H. DALTON.

2. Hall.	Sand and gravel, to London Clay,	15 ft.
3. Union.	,, ,, ,, ,,	17 ,,

4. Toot Hill.

[Glacial Drift.]	[Boulder Clay.]	Blue marl ...	14	40 ft.
		White marl ...	16	
	Gravel, to London Clay		10	

5. The hamlet of Little End is supplied from a public well, with pump, opposite the workhouse. It is shallow, with a strong spring.

Stansted Mountfitchet.

Ordnance Map 222, new ser. (Essex 22, NE., SE., 23, NW., SW.).
Geologic Map 47.

1. Almshouses. ? on western side of road, southward of Railway Station.
Sunk and communicated by Mr. G. INGOLD.
Shaft 46 ft., the rest bored. Water 47 ft. down.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Brick-earth	4	4
	Gravel and loam, very irregularly bedded	30	34
	Gravel	12	46
[Upper] Chalk	... ...	56	102

2. Bentfield End. Waggon and Horses Inn. 1886.
Sunk and communicated by Mr. G. INGOLD.

		Thickness. Ft.	Depth. Ft.
Made ground	... ...	2	2
London Clay.	Brick-earth	6	8
	Blue clay	4	12
	Brick-earth	2	14
	Blue clay	16	30
[Reading Beds.]	Fine grey sand	4	34
	Brown clay	2½	36½
	Mottled clay	2	38½
	Green sandy loam, with a slow spring	4½	43

Stansted Mountfitchet, cont.

3. **Brewery.** On rising ground near the northern end of Stansted Street, northward of Railway Station. 1886.

Made and communicated by Mr. G. INGOLD.

Shaft 40 ft., the rest bored. Water-level 47 ft. down.

		Thickness. Ft.	Depth. Ft.
Made earth		2	2
[Glacial Drift.]	Brown clay, with stones	4	6
	Yellow clay	6	12
	Sandy loam, with stones	6	18
	Sand	2	20
	Gravel	28	48
	Sand, with water	7	55
	Gravel	10	65
	Blue clay	2	67
[Upper] Chalk		60	127

4. Dairy. Just east of the Railway Station. 1889.

Sunk and communicated by Mr. G. INGOLD.

Water-level 15 ft. down.

Chalk	$111\frac{1}{2}$	120 ft.
Clay and gravel	$8\frac{1}{2}$	

5. Hargraves Park. Northern end of the village.

Made and communicated by Mr. G. INGOLD.

Shaft 100 ft., the rest bored.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Brown clay	16	16
	Grey sand	$1\frac{1}{2}$	$17\frac{1}{2}$
	Gravel	1	$18\frac{1}{2}$
[? Reading Beds.]	Mottled loam	6	$24\frac{1}{2}$
	Green sandy loam	$2\frac{1}{2}$	27
	Green sand (water)	7	34
	Blue clay	2	36
	Green sandy loam	5	41
	Brown clay	1	42
[Upper] Chalk		108	150

6. Rochford's Nurseries. On the northern side of the lane and eastern side of the brook, about 530 yds. south-westward of the Railway Station. 1894.

214 ft. (? 224 or 225) above Ordnance Datum.

Information from Mr. ROCHFORD in 1900.

In 1894 about 20,000 gallons a day pumped. This was gradually increased to 120,000 in the summer of 1899.

Rest-level of water up to 8 ft. down (1894). Water has been pumped to 26 ft. down, as a test, with two pumps.

In 1900 water-level 16 ft. down, reduced to 24 ft. by pumping 100,000 gallons in 12 hours.

Loam and some stones	8	30 ft.
Soft soapy Chalk	20	

In 1897 or 1898 bored 50 ft. more. Tube for 20 ft., then firm Chalk.

According to Mr. INGOLD the bore was of 8 in. diameter, and the section gravel about 10 ft., Chalk $67\frac{2}{3}$.

Pumping at this well affects the 1895 well of the waterworks.

Stansted Mountfitchet, cont.

7. Stansted House (? Hall). 1879.

Made and communicated by Mr. G. Ingold.

		Thickness. Ft.	Depth. Ft.
[? Reading Beds.]	Brown clay	23	23
	Mottled red and green sandy clay	17	40
	Grey sandy clay	6	46
	Flints	1	47
[Upper] Chalk ...	... ...	17	64

8. Waterworks. About 500 yds. westward from the Castle Hill.

288 ft. above Ordnance Datum

Information from the engineer, on the spot.

Old well, 88 ft.

In 1897, there were 9 or 10 ft. of water, and pumping had no particular effect on the water-level. In 1898 the well was emptied in half an hour, and water rose only 6 ft. in the well. The deepening of Rochford's Nursery well caused the supply to run short. In April, 1899, a boring of 8 in. diameter was made (? to about 200 ft.), and the water rose to the same level as before and was lowered only a few inches afterwards.

3,000 gallons an hour were pumped in 1900 (more could have been got).

To Chalk about 20 ft., according to Mr. Ingold.

The population supplied is about 2,500. Supply apparently unlimited, 1905.

For analyses of the water, see p. 441.

At Burton End (? Burton Bowers of map) houses were fairly well supplied from wells 20 to 30 ft. deep. Dr. Thresh's Report of 1905, p. 52.

9. Temporary well. Near the western end of the church. 1887.

Made and communicated by Mr. G. Ingold.

Very slow spring.

		Thickness. Ft.	Depth. Ft.
Soil ...	... ...	3	3
London Clay.	Brown sandy clay	8	11
	Black clay, with fragments of shells and iron-pyrites [basement-bed ?] ...	9	20

10. 50 yds. south of the Railway Station. 1893.

Made and communicated by Mr. G. Ingold.

Shaft 31 ft., the rest bored.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Gravel	52	52
	Sand	2	54
	Gravel	8	62
[? Reading Beds.]	Brown loam	4	66
	Blue clay	5	71
	Brown loamy sand ...	2	73
	Stones	½	73½
[Upper] Chalk	... ...	78½	152

For an analysis of water from a boring in Stansted 152 ft. deep in soft Chalk (? this one), see p. 440.

Stansted Mountfitchet, cont.

11. Woodfield. Just westward of Railway Station. 1893.
Made and communicated by Mr. G. INGOLD.
Water at $57\frac{1}{2}$ ft. from the surface.

[Glacial Drift.]	Gravel ...	49	$59\frac{2}{3}$ ft.
[Upper] Chalk	... ...	$10\frac{2}{3}$	

12. Pennington Lane. Borehole for the proposed South Essex Water Board.
About 1 mile northward of Stansted Church. 1900.
Made by R. D. BATCHELOR. Communicated by Messrs. ROFE.
276·46 ft. above Ordnance Datum.
Water-level $59\frac{1}{4}$ ft. down. No water found till between 67 and 68 ft. down

	Thickness. Ft.	In.	Depth. Ft.	In.
Soil	1	2	1	2
[Glacial Drift.] Clay ...	8	4	9	6
[Glacial Drift.] Gravel ...	7	0	16	6
[Upper] Chalk and flints ...	61	6	78	0

For an analysis of the water, see p. 441.

Stanway.

Ordnance Map, new ser. 223 (Essex 27, SW., SE.). Geologic Map 48, NW.

1. Mr. John Brown's, half-mile west of Union House.
Dr. JAMES MITCHELL'S MSS., vol. iii, p. 90.

Dug through gravel	45	165 ft.
Bored through London Clay ...	120	

No water.
[This must reach to very near the base of the London Clay.]

2. At the Union (on the southern side of the road, three-quarters of a mile westward of Lexden Church) the depth to the London Clay was 60 ft.
Dr. J. MITCHELL, *Proc. Geol. Soc.*, 1839, vol. iii, No. 64, p. 131.

3. Blackpits Farm.
Information from Dr. J. W. COOK.
About 128 ft. above Ordnance Datum.
Well 75 ft. deep. Said to go through the London Clay.
The clay is covered here with gravel.
For analysis of the water, see p. 441.

4. Cherry Tree Farm. On the London Road. 1904.
Made by Mr. H. C. SMITH.
Dug 37 ft., bored to 298.
Water-level 102 ft. down. Tested up to 300 gallons an hour.
Chalk reached at 250 ft.
Strata similar to those at Langenhoe Hall.
For analysis of the water, see p. 441.

5. Five Ways Farm.
Dr. J. W. COOK tells us that there is a boring here over 300 ft. deep, with a tube of 5 in. internal diameter.

6. Just south of high road, a mile westward of Lexden. For the Lexden and Winstree Rural District Council.
Communicated by Messrs. SANDS and WALKER.
130 ft. above Ordnance Datum.
Rest-water-level 101 ft. down, lowered to 140 during pumping.
Yield, 14 days pumping at 1,400 gallons an hour.
9-in. bore-hole, lined with steel tubes to 260 ft., the bottom 15 ft. with perforated tubes.

Stanway, cont.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift] Ballast [gravel]	... ...	32	32
[London Clay.]	Yellow clay	3	35
	Blue London Clay	79	114
	Dead sands, with a foot of stone at top, another at 129–130, another at bottom	24	138
[Reading Beds.]	Brown sand	20	158
	Pebbles	2	160
	Mottled clay	19	179
	Brown sand	2	181
	Coloured sands	12	193
	Green sand	7	200
	Grey sand	35	235
	Brown sand	4	239
	Green sand	6	245
[Upper] Chalk	... ...	35	280

In this, as in some Colchester sections (pp. 129, etc.), it is hard to fix the boundary between the London Clay and the Reading Beds.

For analyses of the water, see p. 442.

A small part of Stanway (on the London Road, as far as Beacon End) has been supplied from the Colchester works.

Stapleford Tawney.

Ordnance Maps 240, 257, new ser. (Essex 58, NW. chiefly). Geologic Map 1, NW., and London District, Sheet 2.

Essex Naturalist, 1902, vol. vi, No. 7, p 106.

In an account of an excursion it is noted that there have been "several borings for water surrounding the rectory, and also near the church and hall, at all of which the search was fruitless. One of the bores entered a mass of conglomerate to a depth of six feet without passing through it; this bed extends for about an acre. At the Hall Farm . . there are two good wells of water each about thirty feet deep obtaining their supply from a vein of gravel at about the same depth at which the conglomerate was reached."

The Rev. L. N. Pearce adds, in a letter, that the borings were all of little depth, and that in some gravel was found at the depth of 12 to 16 ft., with some water, but not a good supply.

Suttons. Sir C. Smith's.
Communicated by Sir C. Smith.
Sunk probably 100 to 150 years ago (note of 1900).
About 100 ft. above Ordnance Datum.

Water-level 55 ft. down (Nov., 1900). Had fallen about 25 ft. in recent years.

356 ft. deep. No record of beds passed through. Dr. Thresh thinks that the Chalk is not reached. For analysis of the water, see p. 442.

Stebbing.

Ordnance Map 222, new ser. (Essex 24). Geologic Map 47.

Dr. Thresh, in his Report of 1905, p. 60, says that there were one public well and many private wells, getting water from the gravel (Glacial Drift).

Steeple.

Ordnance Map 241, new ser. (Essex 55, SW., 63, NW.). Geologic Map 2.

1. Cardinal's Well. On the roadside at the western end of the village.
A public well.

Water-level, when repaired in 1903, 18 ft. down. In 1910, $28\frac{1}{4}$ ft. down, and the pump failed. In September, 1910, when pump was out of action, water rose 20 ft. in four days.

Steeple, cont.

2. Public Well. In centre of village, opposite the 'Star.'
Information from Dr. J. C. THRESH and Mr. BLANKS.
Approximately 33 ft. above Ordnance Datum.
Said to be entirely sunk (5-ft. shaft). 150 ft.

In 1903 surface-water was getting in. Water-level then 60 ft. down. Not used during 10 days for repairs and water rose to 13 ft. down. In Feb., 1908, 56 ft. down. For analysis of the water, see p. 443.

The public supply is from these two wells, both of which have been partially reconstructed, so as to prevent the entrance of subsoil-water. Water carted to long distances.

Steeple Bumpstead.

Ordnance Map 205, new ser. (Essex 4, SE., 10, NE.). Geologic Map 47.
Little Waltons Farm. 1901.
Communicated by Mr. H. G. FEATHERBY.
About 230 ft. above Ordnance Datum.
Shaft 46 ft., the rest a 4-in. bore-hole.

[Glacial Drift.]	Boulder Clay	46	58 ft.
	Sandy rubble	4	
	Brown clay (to Chalk) ...	6	

According to Dr. THRESH's Reports of 1901, p. 144, and of 1905, p. 81, there was once a public well, but it failed, and the chief supply was then got from two ponds, an attempt being made to filter the water through sand and polarite.

Now there is no public supply, but many private wells (1913).

Stifford.

Ordnance Maps 257, 271, new ser. (Essex 83, NE.). Geologic Map 1, SW.

1. At a cottage half a mile south-east of the Church. In an old gravel-pit

	Thickness. Ft.	Depth. Ft.
Top of well below surface ...	about 5	5
Steined (and not to be seen) ...	7	12
Thanet Sand	21	about 33
Chalk	30	63

2 Stifford Homes. About half a mile south-westward of the Church. 1908.
An 8-in. boring by Messrs. TILLEY.
Water 67 ft. down, 1908. Yield ample.

		Thickness. Ft.	Depth. Ft.
[River Drift] Gravel		15	15
[Thanet Sand.]	Light-coloured loam ...	37	52
	Dark loam	4	56
	Loam and stones [flints]	1	57
[Upper] Chalk		93	150

According to Dr. THRESH's Report of 1905, p. 27, in North Stifford 10 per cent. of the houses got a supply from private wells, 40 to 60 ft. deep; the rest, and all in South Stifford, getting a supply from the South Essex Co.

Stisted.

Ordnance Map 223, new ser. (Essex 25, NE., SE.). Geologic Map 47.
Stisted Hall. Boring in a field near the Rectory. For the supply of the Hall and the village. 1907.
Made and communicated by Messrs. LE GRAND and SUTCLIFF, and information also from Messrs. SANDS and WALKER.
$7\frac{1}{4}$-in. bore lined throughout, the last 21 ft. perforated.
220 (or 221) ft. above Ordnance Datum
Water-level 105 ft. down.

Stisted, cont.

Yield, 1,500 gallons an hour has been pumped, the water then falling to 115 ft. down.

		Thickness. Ft.	Depth. Ft.
Soil		$1\frac{1}{2}$	$1\frac{1}{2}$
[London Clay.]	Brown clay and stones...	$4\frac{1}{2}$	6
	Brown loamy clay	2	8
	Brown clay and stones...	2	10
	Brown loamy sandstone and clay	16	26
	Sand and gravel	24	50
	Brown clay and stone ...	1	51
	Blue clay	109	160
	Loamy clay and shells ...	$19\frac{1}{2}$	$179\frac{1}{2}$
	Stone	$\frac{1}{2}$	180
	Sand, sandy clay and shells	20	200
	Sandy clay	5	205
[Oldhaven Beds.]	Loamy sand	3	208
	Hard grey sand and pebbles	1	209
[Reading Beds.]	Mottled clay	3	212
	Hard brown clay	18	230
	Soft brown sand	3	233
	Mottled clay	5	238
	Grey and green sand	13	251
[? Thanet Sand.]	Grey sand	29	280
	Coloured fine sand	6	286
	Hard sand	$1\frac{1}{2}$	$287\frac{1}{2}$
[Upper] Chalk		$52\frac{1}{2}$	340

For an analysis of the water, see p. 443.

Stock and Buttsbury.

Ordnance Maps 240, 241, 257, 258, new ser. (Essex 60). Geologic Map 1, NE.

There are three public pumps, one yielding very impure water. The well on the village green (Stock) has water of doubtful purity. The Jubilee pump gives much better water and its supply has not been known to fail as the others do in dry summers. Some of the private wells are highly polluted. Some cottages depended on ponds.

Stow Maries or Stow St. Mary.

Ordnance Maps 241, 258, new ser. (Essex 62, NW., SW.). Geologic Map 1, NE.

1. Great Eastern Railway, Hogwell Siding, nearly a mile east of Woodham Ferrers Station, on the northern side of the line. 1889.

About 22 ft. above Ordnance Datum.

Made and communicated by Messrs. LE GRAND and SUTCLIFF, and from W. T. FOXLEE.

Shaft 35 ft., the rest bored and lined with tubes to the depth of $296\frac{1}{2}$ ft., rising $2\frac{1}{2}$ ft. above the bottom of the shaft.

Water, found at 333 ft., rose to within 15 ft. of the surface. Four days later it had risen $3\frac{1}{4}$ ft. A few days later it stood at 10 ft. below the surface. Yield about 240 gallons an hour.

		Thickness. Ft.	Depth. Ft.
Brickearth		30	30
Blue clay, with clay-stones at $99\frac{1}{2}$–100, $110\frac{1}{2}$–111, 131-$131\frac{1}{2}$ and $321\frac{1}{2}$–$322\frac{1}{2}$		303	333
[Basement-bed ?]	Sand and pebbles, with water...	1	334
	Dead sand; Shells and pebbles	3	337

All the beds must belong to the London Clay.

2. Rectory. Old well.

Information from Mr. PURKIS, the sinker, to W. H DALTON.

London Clay ... 270 } 310 ft.
Sand, to water ... 40 }

There is a public well (probably now disused) at the bottom of the village-street. It is said to be 300 feet deep, and it yields an alkaline water.

Stratford, see **West Ham**, pp. 300–304.

Strethall.

Ordnance Map 205, new ser. (Essex 2, SE., 8, NE.). Geologic Map 47.

The Hall. 1892. Deepened 7 ft., 1894.

Made and communicated by Mr. G. Ingold.

Shaft throughout.

Blue Boulder Clay	31	200½ ft.
Chalk, with layers of clunch at the depth of 115-117½ and of 126-131½	169½	

According to Dr. Thresh's Report of 1905, p. 63, there was a public well and pump, the water coming from gravel in the Boulder Clay.

Stroud Green, see **Rochford.**

Sturmer.

Ordnance Map 205, new ser. (Essex 4, NE., SE.). Geologic Map 47.

1. Dillistone's Nurseries. 1900.

Boring made and communicated by Mr. H. G. Featherby

187 ft. above Ordnance Datum.

Shaft, of 4 ft. diameter, 21 ft., the rest bored, 5 in. diameter in the clear.

Tubes to 120 ft.

Water 2 ft. above the surface, December, 1900. (? when well only 68 ft. deep.)

	Thickness. Ft.	Depth. Ft.
[Boulder Clay.] Blue clay ...	34	34
[Boulder Clay.] Brown clay ...	1	35
Very soft chalk	80	115
Harder chalk	20	135

The following note was made when the well was only 68 ft. deep:—The water would have risen higher (than 2 ft. above ground) but that the chalk-water came up outside the tubes, into the well, and escaped by a drain 2 ft. below ground.

For analysis of the water, see p. 444. Also of one for Mr. Hoffman.

2. Sturmer Hall. 1909.

Made and communicated by Messrs. Duke and Ockenden.

Lined with 4½-in. tubes to 110 ft. down and then 4-in. perforated tubes to 200. Water-level 66 ft. down; lowered 2 ft. when pumping 600 gallons an hour.

[Glacial Drift.] Boulder Clay	72	200 ft.
[Glacial Drift.] Brown clay and pebbles	78	
Chalk and flints, veins of flint at 150 and 164 ft. down	120	

One well and pump used by the public in the village. Several private wells (nearly all shallow).

Sutton.

Ordnance Map 258, new ser., just south-east of Rochford, but not marked thereon (Essex 78, NW.). Geologic Map 1, NE.

According to Dr. Thresh's Report of 1901, p. 80, there was no public supply. A fair number of private shallow wells.

Now in the area of the Southend Water Co., the Sutton well of which is in Eastwood (see p. 149).

Takeley.

Ordnance Map 222, new ser. (Essex 23). Geologic Map 47.

1. Bamborow's Green [? Bamber Green]. 1875.
Made and communicated by Mr. G. Ingold.
Shaft 30 ft., the rest bored.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Boulder clay	56	56
	Dark brown clay	8	64
	Brown clay with stones ...	6	70
London Clay ...	... ...	29	99

2. The Grange.
Made and communicated by Mr. G. Ingold.
Water rose in the well.
Boulder Clay, 43 ft.

3. Jack's Green. 1896.
Shaft. Made and communicated by Mr. G. Ingold.
Water rose from the bottom.
Boulder Clay, 21 ft.

4. Reindeer Inn, lowest part of village.
Sunk and communicated by Mr. G. Ingold.
Shaft 20 ft., the rest bored. No water.

White and blue Boulder Clay ...		72	78 ft.
[London Clay.]	Brown clay ...	2	
	Blue clay ...	4	

5. The Windmill. 1884.
Made and communicated by Mr. G. Ingold.
Shaft $35\frac{1}{2}$ ft., the rest bored. Water $39\frac{1}{2}$ ft. down.

		Thickness. Ft.	Depth. Ft.
Mould	... ...	1	1
[? All Boulder Clay.]	Brown clay	3	4
	White clay	6	10
	Brown clay	10	20
	Blue clay	13	33
	Brown sandy loam ...	$4\frac{1}{2}$	$37\frac{1}{2}$
	Blue clay	8	$45\frac{1}{2}$

Dr. Thresh says, in his Report of 1905, p. 60, that there were three public wells and many private wells, all shallow.

Tendring.

Ordnance Map 224, new ser. (Essex 29, S.W., chiefly). Geologic Map 48, SW.
Union.
Information from Mr. Hatley, well-sinker.
Base of London Clay at 150 ft.

According to Dr. Thresh's Report of 1901, p. 128, there were tube-wells, 21 ft. deep, at the rectory and at a house in the street. The rest of the parish got its supply from shallow wells.

Some houses, from Wix Cross to the Union, are supplied by the Tendring Hundred Company (1905).

Tendring Hundred Waterworks Company, 1884.

Water Works Directory, 1911, pp. 354, 355.
Wells at **Mistley** (which see) **Lawford** (and **Dedham**).
Works established 1884.

Number of houses supplied 4,305. Estimated population supplied, holiday-season, 450,000; normal, 130,000. [Presumably these figures should be

Tendring Hundred Co., cont.

50,000 and 30,000.] Yearly supply, for all purposes, 163,000,000 gallons. Maximum day's consumption, 700,000. Towns and villages within the area of control:—Ardleigh, Beaumont, Bradfield, Dovercourt, Frinton-on-Sea, Great Holland, Harwich, Kirby-le-Soken, Lawford, Little Clacton, Manningtree, Mistley, Parkeston, Ramsey, Stones Green, Thorpe-le-Soken, Walton-on-Naze, Weeley, Wix, Wrabness.

The supply will be extended to Ardleigh and Dedham.

Terling.

Ordnance Map 241, new ser. (Essex 34, SE., 44, NE.). Geologic Map 47.

1. The Place.

Communicated by the late Lord Rayleigh.

Shaft 60 ft., bore about 200 ft. Water rises into the shaft.

Glacial Gravel, sand and loam to about 40 ft.

The rest London Clay, with rock [basement-bed?] pierced through at bottom.

For analyses of the waters of this and of many Terling wells, see pp. 444–446.

2. Upper Green. Nearly three-quarters of a mile westward of the Church. 1868.

Communicated by Sir R. T. Thorne.

A very small quantity of water found.

[Glacial Drift.] Sand and gravel	...	7	16 ft.
Yellow Clay, to ordinary London Clay	...	9	

Thames Haven, see **Corringham.**

Thaxted.

Ordnance Map 222, new ser. (Essex 14, NE., SE., 15, NW., SW.). Geologic Map 47.

1. Cutler's Green, a mile west of the town.

		Thickness. Ft.	Depth Ft.
[Glacial Drift.]	Boulder Clay ...	28½	28½
	Gravel	30	58½
	Blue clay	14	72½
	Quicksand (water) ...	4½	77

2. Near the Church.

	Thickness. Ft.	Depth. Ft.
Soil	4	4
Gravel	40	44
Blue clay	22	66
Quicksand (water) ...	4	70

It is difficult to classify the beds: the lowest two may be Eocene.

3. A mile north of the Church.

Made and communicated by Mr. G. Ingold.

Water-level 22 ft. down.

[Glacial Drift.] Boulder Clay	...	30	34 ft.
Dark sand	...	4	

According to Dr. Thresh's Report of 1905, p. 60, there were eight shallow public wells and many private wells.

In 1912 the Medical Officer reported, concerning sewage-pollution, that the conditions prevailing in Thaxted were disgusting. It is satisfactory to know therefore that a public supply is about to be provided from a deep well into the Chalk.

Theydon Mount.

Ordnance Maps 240, 257 (Essex 50, SE., 58, NE.). Geologic Maps 1, NW., and London District, Sheet 2.

In 1905 largely supplied by a public well or wells. Since then other shallow wells have been sunk on private property.

Thorpe-le-Soken.

Ordnance Map 224, new ser. (Essex 38, NE.). Geologic Maps 48, SW. and SE.

Free's. Malting. North-west of the Railway Station. 1876.
Communicated by P. Bruff.
Surface 35 ft. above low-water mark.
Shaft 50 ft., the rest bored.
Water found at a depth of 370 ft., rose to within 20 ft. of the surface.

			Thickness. Ft.	Depth. Ft.
[London Clay.]		Platimore, as on the shore at Walton [clay] with stone [cement-stone], 11, 8, and 18 in. thick, at depths of 58, 70, and 90 ft.	109	109
	[Basement-bed.]	Sand ... ... Fine brown sand ...	2	111
		Yellowish sandy loam with small flint stones [pebbles]	15?	126?
[Reading Beds.]		Brown coloured [? mottled] clay ...	14	140
		Yellowish sandy loam ... ... Brown clay	7?	147?
		Brown clay	3	150
		Dark (nearly black) fine sand ... *Green platimore	38?	188
		*Green platimore, half clay and half chalk to flints and chalk	1	189
[Upper] Chalk		... ...	251	440

* A specimen from one of these beds showed the clayey green sand that usually occurs at the junction of the older Tertiary beds and the Chalk.

For an analysis of the water, see p. 447.

Many houses are supplied by the Tendring Hundred Water Co. The rest use shallow wells.

Thorrington.

Ordnance Map 224, new ser. (Essex 37, NE., SE.). Geologic Map 48, SW.
Shallow wells (presumably in gravel) were the sole supply (up to 1905).

Thundersley.

Ordnance Map 258, new ser. (69, SW., SE., 77, NW., NE.).
Geologic Map 1, SE.

1. Thundersley Pumping Station. No. 7 well of the Southend Water Works Co. About a quarter of a mile south-west of the Hall. 1898.
Communicated by E. C. Bilham, Engineer to the Company.
Height of works bench-mark above Ordnance Datum 85 ft.
Top of cylinders 2 ft. 7 in. and original ground-level 5 ft. 4 in. below this.
Shaft 332 ft. (8 ft. in diameter), the rest bored.
Lined to 476 ft. 10 in. down with 24-in., 21-in., and 18-in. pipes.
Highest water-level 91 ft. 10 in. down. Lowest (pumping) 324½.

Thundersley, cont.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil ...	... ...	0	6	0	6
[Drift.] ...	Mottled clay [brickearth] ...	2	6	3	0
	Gravel	0	9	3	9
[London Clay.]	Yellow clay	3	3	7	0
	Coloured clay	7	0	14	0
	Brown clay	6	9	20	9
	Clay nodules [septaria] ...	0	9	21	6
	Brown clay	4	6	26	0
	London Clay; very jointy at 179; laminated water vein 2½ ft. thick at 242 ft. 2 in.; bed of blue sandy clay and block of wood 9 in. thick at 260; lignite at 269; sandy clay from 306½ to 308	286	8	312	8
[Lower London Tertiaries, about 151½ ft.]	Hard sand and pebbles ...	5	0	317	8
	Live sand	1	6	319	2
	Dead sand	8	6	327	8
	Hard rock and pebbles ...	1	0	328	8
	Dead sand	19	3	347	11
	Live sand	9	0	356	11
	Dead sand	106	5	463	4
	Flints	0	9	464	1
[Upper Chalk.]	Soft chalk	1	0	465	1
	Flints	0	9	465	10
	Chalk and flints	204	2	670	0

Total depth also given as 675 ft. 4 in.

Water got from the sands of the Lower London Tertiaries. Little, if any, from the Chalk. For an analysis, see p. 447.

2. Burches Pumping Station. No. 8 well of the Southend Water Co. About three-quarters of a mile north-north-east of St. Peter's Church. 1899.
Communicated by E. C. Bilham.
130 ft. above Ordnance Datum.
Shaft 6 ft. diameter to 332 ft. The rest bored and lined to 543 ft. with 24, 21, and 18-in. pipes.
Highest water-level 157 ft. 10 in. down. Lowest (pumping) 306½.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil... ...	... ...	0	6	0	6
[Drift.]	Yellow clay	2	6	3	0
	Gravel	1	0	4	0
[London Clay.]	Mottled clay...	11	0	15	0
	Brown clay	5	0	20	0
	London Clay; bed of clay nodules [septaria] at 255 and bed of nodules and seams of sand at 280 ft.	335	9	355	9
	Pebbles	0	9	356	6
[Lower London Tertiaries, 141¾ ft.]	Hard sand	3	6	360	0
	Live sand	4	0	364	0
	Hard sand	3	6	367	6
	Live sand	14	0	381	6
	Hard sand	2	1	383	7
	Live sand	16	11	400	6
	Dead sand	3	6	404	0
	Hard rock	0	9	404	9
	Sandy clay	93	3	498	0
	Flints	0	3	498	3

Thundersley, cont.

		Thickness. Ft.	In.	Depth. Ft.	In.
[Upper Chalk, 346¾ ft.]	Soft chalk	9	0	507	3
	Flints	0	3	507	6
	Chalk and flints	252	6	760	0
	Dark blue clay and chalk ...	0	6	760	6
	Grey sandy chalk, very hard	1	0	761	6
	Softer chalk	21	6	783	0
	Hard chalk	31	0	814	0
	Softer chalk	28	6	842	6
	Dark grey chalk	2	6	845	0

Total depth given as 854.
Water from the sands of the Lower London Tertiaries. Little, if any, from the Chalk. For an analysis, see p. 448.

A few houses near the church got water from the Southend Co., the rest of the parish used surface-wells yielding abundant water but of poor quality. (Dr. Thresh's Report of 1901, p. 80.)
Many houses built since have been connected with the Company's mains.

Tilbury Fort, see West Tilbury.

Tilbury-juxta-Clare.

Ordnance Map 206, new ser. (Essex 11, NW. and NE.) Geologic Map 47.

1. Tilbury Court. South-east of the Church. 1903.
Made and communicated by Messrs. Merryweather.

		Thickness. Ft.	Depth. Ft.
	Dug well (old, the rest bored)	—	75
	Blue [Boulder ?] Clay	20	95
[Chalk.]	White marl	130	225
	White marl and flints ...	27	252
	Hard stone	1	253
	White marl	22	275
	White marl and flints ...	93	368

Judging from the geologic map one would expect to find gravel between the Boulder Clay and the Chalk. Perhaps it was found in the well, and there may be a lower bed of Drift Clay. The description of the beds below as marl is suggestive of a deep channel of Drift; but probably the material is soft Chalk In one note it is described as putty-like.

2. According to Dr. Thresh's Report of 1905, p. 65, there were many private wells, from 35 to 40 ft. deep.

A few houses are supplied with spring-water.

Tillingham.

Ordnance Map 242 (Essex 55, SE). Geologic Map 2.

1. Tillingham Hall (near the Church).
Boring (5 in. diameter) made and communicated by Mr. H. C. Smith.
68 ft. above Ordnance Datum.
Water-level 65 ft. down (1911).
Yield (pump 81 ft. down) 2,200 gallons per hour. Much more could be obtained (1911).
Chalk reached at 390 ft. down; water reached at 470; total depth 495 ft.
For analysis of the water, see p. 448.

Tillingham, cont.

2. Marsh Farm (? Marsh House of the map).

Mr. George Raby, of Tillingham Hall, says he has a bore there 300 ft. deep. He says that the water was distasteful at first to people brought there from Fyfield, but that later they grew not to mind it at all.

A partial analysis of the water appears on p. 448.

According to Dr. Thresh's Report on the Water Supply of Essex, 1901, p. 111, the place was supplied from three public pumps and from a number of shallow wells. The public pumps yielded fairly good water; but the supply had become very short in recent summers, though the wells had been deepened.

The public wells are only 10 to 15 ft. deep, in gravel. In the Report of 1905, p. 41, six public wells are mentioned; but the deficiency of water in dry weather still held. There was a supplementary pump, from a brook.

Tindon End, see **Great Sampford,** p. 174.

Tiptree.

Ordnance Map 241, new ser. (Essex 45). Geologic Map 47.

Tiptree is apparently in more than one parish, part in Tolleshunt Knights, part in Inworth, and part in Messing.

Messrs. Thorne and Livermore's (Tiptree Heath) Brewery. 1889.

A little over 200 ft. above Ordnance Datum.

Made and communicated by Messrs. Isler and Co.

Lined with 420 ft. of 5-in. tubes from 6 ft. down.

Water-level 154 ft. down.

Yield (never really tested) said to be 10,000 to 20,000 gallons a day (? 700 an hour, with pump 400 ft. down).

		Thickness. Ft.	Depth. Ft.
Dug well		—	6
[Drift.]	Running sand	3	9
	Gravel	6	15
Blue [London] Clay		262	277
[Lower London Tertiaries.]	Mottled clay	12	289
	Sand and clay	10	299
	Stone	4	303
	Sand and clay	9	312
	Sand and pebbles	7	319
	Black sand and clay	13	332
	Hard sand	10	342
	Black sand and clay	41	383
	Clay	7	390
	Sand and clay	6	396
	Sand clay and pebbles	4	400
	Brown clay and sand	3	403
	Sand and clay	5	408
Upper] Chalk and flints		154	562

? Deepened to 601 ft. For an analysis of the water, see p. 449.

It is difficult to understand the section between the London Clay and the Chalk, as the details do not agree with what one would expect in the Lower London Tertiaries here. Perhaps the peculiar disturbance affecting the Wickham Bishop boring (see p. 312) may extend here. Indeed, Mr. Dalton, who sent me the section (which was published as in Messing in *Essex Naturalist*, vol. iii, p. 51), was inclined to classify the beds between 319 and 383 ft. as London Clay, repeated (as at Wickham) in the lower series.

Tollesbury.

Ordnance Map 241, new ser. (Essex 46). Geologic Maps 2 and 48, SW.

1. Tollesbury Marsh.
From Mr. PURKIS, well-sinker, (from memory).

		Thickness. Ft.	Depth. Ft.
Alluvium		50	50
London Clay		130	180
[?Lower London Tertiaries, 60 ft.]	Sand	4	184
	Clay	2	186
	Sand	14	200
	Clay	8	208
	Sand	32	240

2. Wick Marsh Farm.
Information from Dr. SMITH.
1 to 2 ft. below level of spring high tides.

Water overflows from bore-pipe 8 ft. below ground-level, at the rate of 1 gallon in forty minutes.

Marsh-water may get into the well though not into the bore-pipe.

For an analysis of the water, see p. 449. Also of that from public pump.

According to Dr. THRESH's Report of 1901, pp. 111, 112, there were then two public wells, one very polluted, as also were the many private wells.

These wells are still in use; but on account of the growth of the place a public supply has been decided on and a bore made. See below.

3. Trial-bore in the village for the Maldon Rural District Council. 1912.
75 ft. above Ordnance Datum.

Water-levels, when the boring was 187 ft. deep, 66 ft. down (Jan., 1911); when 256 ft. deep, 68 ft. down (March, 1911); when 358 ft. deep, less than 75 ft. down (July, 1912).

For analyses of the water in various stages of construction, see pp. 449, 450.

		Thickness. Ft.	Depth. Ft.
Earth and sand		2	2
Gravel and sand with water...		16	18
[London Clay.]	Yellow clay	3	21
	London Clay with loam. Stones at the bottom	149	170
	Sand stone	$\frac{3}{4}$	$170\frac{3}{4}$
	Sandy clay	$26\frac{1}{4}$	197
[Lower London Tertiaries.]	Green sand with water...	13	210
	Dappled clay	4	214
	Yellow clay	6	220
	Mottled clay	25	245
	Green sand with water...	10	255
	Sand	9	264
	Dark clay	33	297
	Yellow clay	3	300
[Upper Chalk.]	Chalk	10	310
	Flints in chalk	1	311
	Chalk containing water	47	358

Tolleshunts, The.

Ordnance Map 241, new ser. (Essex 45, NE., SE., 46, NW., SW.).
Geologic Map 48, SW.

Dr. THRESH's Report on the Water Supply of Essex, 1901, p. 111, with some later information:—

Tolleshunt D'Arcy.—The whole village was supplied by shallow wells, very many of them polluted. Many people carted water from a spring at Spring Farm. (There is another at Limesbrook Farm, but neither yielded enough to supply the village.)

Tolleshunts, cont.

A few houses at the Tiptree end of the parish are supplied from the Tiptree mains.

At High Hall (Farm), Tolleshunt D'Arcy, there is a well 118 ft. above Ordnance Datum, 39 ft. deep, said to be wholly in loam [? sandy London Clay]. After the well had been sunk some time the water rose to within 7 ft. of the ground. The water, for an analysis of which see p. 451, is remarkable for its extraordinary amount of common salt.

There are also two very old bored wells at this farm, one sunk 100 ft. and bored 200, the other sunk 50 and bored about 200. Their water was evidently not fit for use, as they were both turned into cess-pools for the liquid from the farmyard.

Tolleshunt Knights.—No village. At Tiptree Heath water was got from springs and shallow wells; but the chief supply was from ponds and brooks. The brook chiefly used was polluted in 1899, and water had to be carted from a distance.

A public supply has since been provided. Water from a gravel-patch in Messing is pumped, by a wind-engine, to a reservoir on high ground, flowing thence through some miles of mains it supplies houses and farms on the way.

See also under Messing, p. 224.

Tolleshunt Major, or *Beckingham.*—There was a public well and a spring (which has recently been piped to the roadside, to supply the houses near, 1914). A few houses had private wells, some showing signs of pollution. Some cottages had rain-water tanks.

Toppesfield.

Ordnance Maps 223, 206, new ser. (Essex 11, NW., SW.).
Geologic Map 47.

Thurston's Farm, near Robinhood End, west-south-west of the village (published previously as Hood End).
Said to have gone through 140 ft. of Boulder Clay.

According to Dr. THRESH's Report of 1901, p. 121, the chief supply of the village was from a spring, the water being pumped by a hydraulic ram. There were also two public wells.

His Report of 1905, p. 64, adds that two public pumps then supplied about two-thirds of the inhabitants. A few houses were supplied by a spring at Scotney's Farm, which needed (and still needs) protection from pollution. There were many wells, 30 to 40 ft. deep; but water was hard to get in certain parts, and probably 10 per cent. of the people used pond or brook.

In 1913 there were seven public pumps in the parish, two being in the village, one pumping from an underground reservoir (? fed by the spring first mentioned).

Totham, see Great Totham.

Twinstead.

Ordnance Map 223, new ser. (Essex 12, SW., SE.). Geologic Map 47.

According to Dr. THRESH's Reports of 1901, p. 139, and of 1905, p. 80, there were two public wells, into Chalk, yielding good water, one of which had to be deepened (before 1905) to 82 ft.

There are also several private wells.

Ugley, or Oakley.

Ordnance Map 222, new ser. (Essex 13, SE., 14, SW.). Geologic Map 47.

1. Wade's Hall. Less than a mile south-south-west of the church. 1875.
? About 310 ft. above Ordnance Datum.
Made and communicated by Mr. G. INGOLD.
Shaft throughout.

[Glacial Drift.]	White clay	18	100 ft.
	Brown sandy loam ...	12	
Chalk	... ...	70	

Ugley, cont.

2. Ugley Green. Mr. J. E. Waithman's. 1909.

Made and communicated by Messrs. ISLER & Co.

Lined with 10 ft. of 5-in. tubes from 5 ft. down; 90 ft. of 4-in. tubes from 3 ft. down.

Water-level 111 ft. down. Supply 360 gallons an hour.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Clay and flints	5	5
	Ballast [gravel]	4	9
[? Reading Beds.]	Mottled clay	14	23
	Red sand	3	26
	Blue clay	26	52
	Brown clay	5	57
	Mottled clay	8	65
	Sandstone	2	67
	Green sand	15	82
	Dark green sand	5	87
	Green-coated flints	1	88
[Upper] Chalk and flints		77	165

No Reading Beds have been shown on the Geologic Map here; but the mottled clay, green sand, &c., read as if they belonged to that formation rather than to the Drift. There may be a hidden outlier, below the Drift, or the main mass may extend over here. The above thickness, however, is more than one would expect for the Reading Beds.

According to Mr. INGOLD the wells at the Chequers and the Vicarage are 100 and 95 ft. deep, the lower part being in Chalk.

According to Dr. THRESH's Report of 1905, p. 53, the village, except for some houses at Patmore End, is supplied from wells 20 to 30 ft. deep.

Ulting.

Ordnance Map 241, new ser. (Essex 44, SE.). Geologic Map 1, NE.

The Vicarage, in the grounds.

No definite information. Well probably sunk 20 to 25 ft. and bored another 130 to 140; through surface-clay and London Clay, getting water from sand immediately below the latter.

For an analysis of the water, see p. 451.

Upminster.

Ordnance Map 257, new ser. (Essex 75, NW.). Geologic Maps 1, SW., and London District, Sheet 2.

1. Hoppea Hall. Corbets Tye road.

A 6-in. boring. Made and communicated by Messrs. R. RICHARDS. & Co.

Water-level 142 ft. down. Supply ample.

		Thickness. Ft.	Depth. Ft.
[River Drift.]	Stony clay	6	6
	Ballast [Gravel] full of water	8½	14½
[London Clay.]	Stony clay	1½	16
	Blue clay	21	37
	Clay	137	174
	Sandy clay and clay	50	224
	Sandy clay	26	250
	Sand with a little clay	28	278
[Lower London Tertiaries.]	Green sand and clay	6	284
	Sand with clay	35	319
	Sand	52½	371½
	Hard sandy clay	3	374½
[Upper] Chalk and flints		173½	548

Upminster, cont.

2. Upminster Court. Hall Lane. In the stable-buildings.
Communicated by Mr. A. E. WILLIAMS.
About 133 ft. above Ordnance Datum.
Water-level 140 ft. down.
Yield unknown. Capacity of pump 500 gallons an hour.
Water sometimes a little chalky after heavy pumping. For analysis, see p. 451.

	Thickness. Ft.	Depth. Ft.
Gravel	15	15
London Clay	300	315
Reading [and Thanet] Sand ...	85	400
[Upper] Chalk	150	550

3. Rectory.
Dr. J. MITCHELL'S MSS., vol. iii, p. 75.
Dug 90 ft., the rest bored.

Sand, gravel, and brick-earth	30	180 ft.
Blue [London] Clay, ending in brown sand and black pebbles [basement-bed ?]	150	

4. Mr. JAMES BROWN wrote, in 1904, that at his works a water-bearing bed of gravel had been found, perhaps about 20 ft. down, below Boulder Clay, in the large pit. This water comes out in the lane about 600 yds. north of the well. It also appears on the south-east of his holding, and has been tapped at intermediate spots. It never fails, even in the driest seasons. It is not found at Martyn's Farm, where there is a well some 60 ft. deep and very foul.

Vange.

Ordnance Map 258, new ser. (Essex 76, NE.). Geologic Map 1, SE.
According to Dr. THRESH'S Report on the Water Supply of Essex, 1901, p. 85, the population was about 500; the supply, supplemented in places by rain-water, was from a private well about 700 ft. deep (No. 1, below); some of the inhabitants carted water $1\frac{1}{4}$ miles, paying twopence for a small butt.
The Southend Water Co. now supply the village.

1. Brickyard. On the eastern side of the road south-eastward of Vange Hall. (Mr. T. L. Curtis.) 1884.
Sunk and communicated by Messrs. LE GRAND and SUTCLIFF. Addition, 1889.
115 ft. above Ordnance Datum. (Below the 100 ft. contour-line. J. C. T.)
Shaft 100 ft., the rest bored. Water-level 99 ft. down.
First 150 ft. of the Chalk practically waterless. Sufficient supply got from the next 50. (? Did not last, as the boring was deepened.)
Yield about 600 gallons an hour (1898).

		Thickness. Ft.	Depth. Ft.
London Clay ...	... ...	395	395
[? Oldhaven and Blackheath Beds, $42\frac{1}{2}$ ft.]	Dead sand and shells	$3\frac{1}{2}$	$398\frac{1}{2}$
	Grey sand	$2\frac{1}{2}$	401
	Pebbles	1	402
	Dead sand	4	406
	Grey blowing sand	$12\frac{1}{2}$	$418\frac{1}{2}$
	Pebbles	$\frac{1}{2}$	419
	Grey sand and pebbles...	2	421
	Grey sand	$17\frac{1}{2}$	$438\frac{1}{2}$
[Woolwich and Reading Beds, 47 ft.]	Sandy clay	2	$440\frac{1}{2}$
	Peat [lignite ?]	2	$442\frac{1}{2}$
	Blue clay	3	$445\frac{1}{2}$
	Brown clay	5	$450\frac{1}{2}$
	Sand and shells	5	$455\frac{1}{2}$
	Peaty clay	20	$475\frac{1}{2}$
	Sand and pebbles	10	$485\frac{1}{2}$

Vange, cont.

		Thickness. Ft.	Depth. Ft.
[Thanet Beds, 38½ ft.]	Dead sand	22	507½
	Dark sandy clay	12	519½
	Dark greenish clay	3	522½
	Green flints	1½	524
Chalk. The first 150 ft. soft and impure, with very little water; a bed of clay at 600 to 603 ft., and then a mixture of clay, chalk, and flints; then white chalk and flints		177	701
Since bored deeper in [Upper] Chalk		119	820

This boring is of interest as showing what seems to be a fairly thick development of the Oldhaven Beds some way from their outcrop. In this series and in the beds below, the sands (which would have been expected to yield water) were blowing sands, and to pass through them the pipes had to be kept full of water. For analysis of the water, see p. 452.

2. Public-house.
From H. W. Bristow's Notes.

Black clay (alluvium)		10 or 12	100 ft.
[London Clay.]	Brown clay, Blue clay, about	90	

3. The Southend Water Co.'s No. 14, or Pitsea, Well. ¾ mile WSW. of Pitsea Church.
Communicated by E. C. Bilham, Engineer to the Company.
27·5 ft. above Ordnance Datum.
Sunk portion 250 ft., 24-in. pipe to 262, the rest unlined 24-in. diameter.
Highest water-level 70 ft. down. Lowest (pumping) 220.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil		1	0	1	0
[London Clay.]	Yellow clay	11	0	12	0
	Brown clay. Layer of nodules [septaria] at 27	20	0	32	0
	Blue clay. 10 layers of nodules [septaria] last at 204½ ft.	232	0	264	0
	Pebbles	0	6	264	6
[? Oldhaven Beds]	Sand	3	9	268	3

Water from sands of Lower London Tertiaries. For analyses, see p. 426.

Victoria Docks, see **West Ham.**

Wakes Colne.

Ordnance Map 223, new ser. (Essex 17, SE.). Geologic Maps 47, 48, NW. and SW.
The Green (about a mile northward of the church). For the Local Sanitary Authority. 1887.
Made and communicated by Mr. J. Beard, of Chapel.

			Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	[Boulder Clay.]	White clay	25	25
		Blue clay	6	31
	Sandy loam		9	40
	Red gravel		10	50
	Light-coloured gravel		5½	55½
	Pebbles		½	56
	White sand with water		5	61

According to Dr. Thresh's Report of 1901, p. 133, at Wakes Hall the supply was pumped from a stream and continued to some cottages belonging to the same owner. The rest of the houses were generally supplied from shallow wells.

Wallasea, an island opposite Burnham, in more than one parish.
Ordnance Maps 258, 259, new ser. (Essex 71). Geologic Map 2.

Boring toward the western end of the island (above Burnham).
Made and communicated by Mr. F. Bennett, of Ipswich. 1902.

Boring begun with a tube of 6 in. diameter, which was stopped by a rock, when a smaller tube was driven to a depth of 444 ft. Much troubled with running sand and rock.

		Thickness. Ft.	Depth. Ft.
Soil		1½	1½
[London Clay, with some Alluvium above.]	Light-coloured loam	6	7½
	Dark loam	28½	36
	Blue clay	35	71
	Light-coloured clay with stones at the depths of 78, 87, 151, 210 ft.; rock, 14 ins. thick, at 238½; stones at 284 and 300; rock (8 ins.) at 318; stone at 380	311	382
	Loam, with rock, 17 ins. thick, at 383 ft. and, 14 in. thick, at 386; stones at 388 and 393½	11½	393½
	Light-coloured sand	10	403½
	Blue clay, with stone at 411½	8	411½
	Green loam, with hard red sand pan [hard bed] 7 ins. thick, at 429	36½	448
	Blue clay	28	476
	Dark green loam, hard pan	¼	476¼
	Green clay	2¼	478½

Waltham Abbey.

Ordnance Maps 239, 240, 256, 257, new ser. (Essex 49, NW. and SW., 57).
Geologic Maps 1, NW. and (part) London District, Sheet 2.

1. Brewery. 1841.
Communicated by Mr. T. Chatteris.

	Ft.
Gravel and clay	about 90
Blue London Clay	
Bed of chalk [? stone] with sand and a good spring of water [? basement-bed of London Clay]	
Green sand, &c., to Chalk	,, 70

Sir J. Prestwich thought that the depth to the base of the London Clay was about 40 ft., as the mottled clay of the Reading Beds might perhaps have been included in the thickness of the London Clay. *Quart. Journ. Geol. Soc.*, vol. x, p. 403.

2. Galley Hill. Aime's Green Well, NNE. of the town. 1898.
Made by Messrs. Isler & Co. Communicated by Col. B. R. Colvin.
About 300 ft. above Ordnance Datum.
Dug 95 ft.; bored to 347 ft. Water-level 97 ft. down (1898).
Not used now (1909).

For analysis of the water, see p. 454.

3. Joyce's Percussion-cap Factory.
Communicated by Mr. F. Joyce (? about 1860).

		Thickness. Ft.	Depth. Ft.
Mould		1½	1½
[? Valley Drift, 7 ft.]	Loam and clay	3	4½
	Yellow clay	3½	8
	Gravel (water)	½	8½
London Clay, to green sand [Woolwich Beds]		85½	94

Waltham Abbey, cont.

4. Larsen's Nurseries. 350 ft. from Cobbin's Brook, and half-way between Honey Lane and Sewardstone Road.

About 70 ft. above Ordnance Datum.
Made and communicated by Messrs. R. Richards & Co.
Boring 12 inches in diameter.
Water-level 8 ft. above Ordnance Datum (62 ft. down).
Yield 6,000 gallons an hour.

	Thickness. Ft.	In.	Depth. Ft.	In.
Sump-hole	—		12	0
Blue (London) Clay	61	0	73	0
Sand with thin layer of sandstone	8	0	81	0
Green sand	9	0	90	0
Sand stone	2	10	92	10
Shells	2	0	94	10
Black clay	1	0	95	10
Mottled clay	0	2	96	0
Shells	0	6	96	6
Grey sand	2	0	98	6
Sand and small stones	8	6	107	0
Green sand	4	0	111	0
Sand and small stones	4	0	115	0
Sand	5	0	120	0
Sand and gravel	8	0	128	0
Thanet sand (with a few pebbles)	28	0	156	0
Green flints	0	6	156	6
[Upper] Chalk with layers of flint	193	6	350	0

It is difficult to classify the beds. It looks as if there might be some Oldhaven Beds. The occurrence of two layers of shells beneath the London Clay is peculiar.

For analysis of the water, see p. 454.

5. Monkham Park (Monkham Hall of newer map). North of the town.

From a paper (privately printed at Cheshunt in 1852) with some additions (in brackets) from the inspection of a small collection of specimens belonging to Mr. R. W. Mylne, who kindly showed them to me; and from Mr. T. Docwra.

About 200 ft. above Ordnance Datum.
Shaft 225 ft., the rest bored, starting at 7 ins. diameter.
Water-level about 175 ft. down.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Brown clay	20	20
	Blue clay	150	170
	Hard brown clay	50	220
	Hard brown sand [basement-bed?]	5	225
[Reading Beds. 58 ft.]	Dark (grey, fine) sand	11	236
	Coloured (mottled) clay	11	247
	Dark green (mottled) sand	10	257
	White silvery (light-grey) sand, on touching which the water rose from 8 to 9 ft. an hour in the shaft, to a height of 50 ft. from the bottom	10	267
	Green (light-grey) sand in beds of [black flint] pebbles. [bottom bed ?]	5	272
	Light-grey sand without pebbles. [bottom bed ?]	5	277
	Grey sand with pebbles [bottom bed ?]	6	283

Waltham Abbey, cont.

		Thickness. Ft.	Depth. Ft.
[Thanet Sand ? 21 ft.]	Dark green sand	17	300
	Hard dark sand	3	303
	Flints (green coated)	1	304
Chalk full of dark flints		11	315
Slate rock		12	327
Sandy rock		8	335
Green live sand		45	380

At a depth of 70 ft. carbonic acid gas issued from the side of the shaft, in which were pieces of fossil wood, and a layer of cement-stone a foot thick.

At 77 ft. some small fossils were found.

At 170 ft. carbonic acid gas issued from one side of the shaft so much that candles would not burn. Bellows were then fixed at the top to supply pure air to the men at work in the shaft.

At the last bed the water in the shaft sunk a foot, and it was then thought better to leave off boring and to plug the bore with clay up to the last layer of flints in the Chalk. When this had been done the water rose to its original height in the shaft.

The water was examined by Mr. F. Joyce, who found 79 grains of solid matter in the gallon (carbonate and sulphate of lime, chlorides of sodium and of calcium, a little oxide of iron and vegetable matter, besides some free carbonic acid gas). It was soft and well suited for domestic purposes.

I cannot understand the last three beds. In Mr. Mylne's collection of specimens there are two samples said to have come from below the Chalk; the one next to that rock being simply sand, just like the sample of Thanet Sand, from an oblique pipe of which it may have come; whilst the lowest sample is a piece of cinder. It would not be safe therefore to depend on the lowest part of this well-section.

Col. R. B. Colvin says there is a well here $220\frac{1}{3}$ ft. deep (? a newer one than the above).

200 ft. above Ordnance Datum.

Water-level 195 ft. down (December, 1909), having risen 7 ft. since December, 1908.

For an analysis of the water, see p. 454.

6. Sewardstone. Spencer's Farm, a few years before 1874.

Communicated by A. Sheldon.

About 47 ft. above Ordnance Datum.

Sunk and bored 80 ft. In 1874 water rose just to the surface.

[? From just below the London Clay.]

7. Sewardstone.

Prestwich, *Quart. Journ. Geol. Soc.*, vol. x, p. 403.

To the bottom of the London Clay, 122 ft.

8. Close to Waltham Lock. East London Waterworks, now Metropolitan Water Board. 1888.

Communicated by W. B. Bryan, Engineer to the Company.

60 ft. above Ordnance Datum.

Shaft, 12 ft. diameter, with galleries in the Chalk northward and southward.

The level of the Chalk-water, before pumping began, was within a foot of the surface.

In May, 1886, Mr. Bryan told me that 200 gallons of water a minute were rushing in from just beneath the base of the clay, 60 ft. down, the water being beautifully bright and clear.

In April, 1899, 750,000 gallons were being pumped daily.

Before throwing open all the bore-holes in the bottom permanently the yield was carefully gauged and found to be rather more than 5,000,000 gallons a day. The water could not be lowered more than 70 ft.

Waltham Abbey, cont.

		Thickness. Ft.	In.	Depth. Ft.	In.
[Alluvium.]	Soil	1	0	1	0
	Yellow clay	2	6	3	6
	Peat	4	6	8	0
Ballast [River gravel]	... ...	10	0	18	0
[London Clay, 38 ft.]	Blue clay	26	0	44	0
	Sandy clay, with 3 ins. of Fullers' earth at top, and 7 ins. of white stone, beginning 5 ft. down	10	6	54	6
	[Basement-bed.] Sand and shell ...	0	4	54	10
	[Basement-bed.] Fine, light-coloured, hard sand	1	0	55	10
	[Basement-bed.] Black stone, pebbles ...	0	2	56	0
[Reading Beds, 38½ ft.]	Blue clay	8	0	64	0
	Sandy clay	4	0	68	0
	Fine, white sand	5	0	73	0
	White, sandy clay	1	0	74	0
	Greenish sand	8	0	82	0
	Lighter-coloured sand	3	0	85	0
	Very light-coloured sand	5	0	90	0
	Sharp coarse sand	4	6	94	6
[Thanet Sand, 28½ ft.]	Fine sand, getting darker lower down	27	9	122	3
	Large flints	0	9	123	0
[Upper] Chalk, firm throughout	... ...	75	0	198	0

For analyses of the water, see p. 453.

9. War Department.

The following is from a Memorandum as to artesian wells on the property of the War Department, Waltham Abbey, by Major F. Edmondes, R.E., February, 1886, and though no section of the wells is given the particulars are of interest.

The water of the dwelling-houses of the officers and hands of the factory was from a well at the back of the Gun-cotton Works. This well was in existence when this part of the factory was acquired, and its exact depth is not known. ? 100 ft. or more.

It had given a continual supply equal to requirements for the last twenty-five years. After exceptional seasons of drought the supply lessened. It was said that twenty years ago the delivery had been 5 ft. above ground; then it was only 1½.

The well in Powder Mill Lane became silted up, and had been rebored ten or twelve years ago. It was cleared to a depth of 95 ft., and the supply had since been continuous.

The water (? of both wells) flowed into tanks at ground-level, and from these was pumped into high-level tanks, for pressure.

10. King's, watercress-grower. Old well.

In Sir J. Prestwich's MSS. is a note of a well here, through 18 ft. of gravel and 40 ft. of clay, sunk 90 ft. to sand-spring (? water rose to surface).

11. According to Mr. T. Clark (*MS.* in *Library Inst. Civ. Eng.*) a well at Waltham Abbey touched the Chalk at 120 ft., and water overflowed.

The following notes were made by W. Topley in 1886:—

The water-supply of Waltham Abbey was from three sources.

1. Shallow wells, in the loam and gravel [River Drift], the water of which was held up by the London Clay. In such wells the water was liable to be foul, and it was so in the lower parts of the town, where it was used only for rough household purposes, water for drinking and cooking being got from the public wells or fountains. The water from these wells in the higher part of the town was said to be of better quality. The number of these wells must have been considerable.

Waltham Abbey, cont.

2. Wells and borings through the London Clay to the sands, &c., between that and the Chalk, in which sands water was generally found, and it overflowed in many instances. But the water-level of late years had been slightly lowered, from increase in the number of wells. Of the four public fountains, those in Fountain Lane, Fountain Place and Greenfield Street got their water from this source. In the first of these the water always overflowed at a stand-pipe; in the others it rose to about, or sometimes a little above, the surface.

3. Wells or borings into the Chalk, generally into the upper part of the Chalk only. In these too, the water rose to, or slightly above, the surface. The public fountain in Romeland was of this kind.

In all there were in Waltham Abbey and its immediate neighbourhood about twelve deep private wells and four public wells.

This reference to what is probably a more or less past state of things by so expert a man as my late friend and colleague is of interest.

Walthamstow.

Ordnance Map 256, new ser. (Essex 65, NW. and SW.).
Geologic Maps 1, SW., and London District, Sheet 2.

1. Clay Street. (Mr. Robertson's.)
Dr. J. Mitchell's MSS., vol. iii, p. 83.
Dug 90 ft., bored 100. To Chalk (190 ft.).

2. Essex Brewery, near St. James' Street Station. Two wells.
'Epping Forest' . . . by F. Collier, undated (? soon after 1880), pp. 31, 32.

Supply from two sources, both copious. One from the beds next below the London Clay, at the depth of 90 ft., soft and used for cooling, washing, etc. The other from 180 ft. down in the Chalk, used for brewing only.

	Thickness. Ft.	Depth. Ft.
[River Drift] Gravel ...	11	11
London Clay	81	92
Woolwich Beds ...	29	121
Thanet Sand	61	182
Chalk	180	362

3. Messrs. Collier wrote, however, in 1893, that, the water-level having dropped from 30 ft. to 50 ft. down, a second well was sunk in 1892, about 30 ft. from the older one. This was made by Messrs. Baker, who have contributed the following particulars:—

Shaft 111 ft., the rest bored.
Water-level 48 ft. down. Continuous pumping, with a pump of 8 in. diameter, lowered the water only 11 ft.

			Thickness. Ft.	Depth. Ft.
Mould			3	3
[River Gravel] Rough Ballast			10	13
[London Clay, 101 ft.]	Brown clay		57	70
	Petrified timber		1	71
	Brown clay		18	89
	Mottled clay		21	110
	[Basement-bed]	Pebbles ...	1	111
		Septaria ...	2	113
		Shelly bed	1	114
[Reading Beds, 38 ft.]	Brown sand and white marl ...		7	121
	Dark loam		17	138
	Sand and pebbles		8	146
	Dark sandy clay		6	152
[Thanet Sand, 28 ft.]	Thanet Sand		27	179
	Green-coated flints		1	180
[Upper] Chalk			186	366

Walthamstow, cont.

4. Essex Brewery. Third well. 1902. From Memoir on London Wells.
45 ft. above Ordnance Datum.

Water-level 45 ft. below O.D. Supply 10,000 gallons an hour.

	Thickness. Ft.	Depth. Ft.
Made ground and River Drift ...	32	32
London Clay	43	75
Woolwich Beds and Thanet Sand ...	101	176
Upper Chalk	199	375

5. Walthamstow Marsh. East London Water Co., now Metropolitan Water Board (at the former Copper Mill).

From specimens shown to me by Mr. Maine, foreman of the works at the new reservoirs (1863, 66). Down to 96 ft. specimens seem to have been taken at nearly each yard in depth.

Surface of ground 15 ft. above Trinity High Water Mark.

		Thickness. Ft.	Depth. Ft.
London Clay, 63 ft.*	Blue clay, sandy at bottom, and with nodules of iron-pyrites	57?	57
	Basement-bed? Clayey sand with shells (*Cyprina*)	3?	60
	Basement-bed? Clay and pebbles ...	3?	63
Reading Beds, 46½ ft.	Mottled clay of various colours ...	18?	81
	Mottled clay, rather sandy	3?	84
	Light-greenish-grey sand, and then hard, white stone about 5 ft. thick ...	6?	90
	Light-greenish-grey sand	6?	96
	Grey sandy clay and pebbles	4?	100
	Grey sandy clay, pebbles, and green sand	9½	109½
Thanet Sand, 42½ ft.	? Grey clayey sand	10½	120
	? Grey sand	30½	150½
	Green-coated flints	1½	152
Upper Chalk, 140 ft.	Chalk with flints	123	275
	Chalk with flints, very hard	5	280
	Chalk with flints	12	292

* This must include the alluvium and gravel above the London Clay.

6. Another well within 10 yds. of the last. 1888.

Communicated by W. B. Bryan, Engineer to the Company. With additional information from Messrs. S. F. Baker and Son.

27 ft. above Ordnance Datum.

Cylinders 14 ft. diameter, and shaft with headings in the Chalk. Water stood about 50 ft. down. Yield, when 202 ft. deep (and ? with 200 ft of heading), about two million gallons a day.

		Thickness. Ft.	Depth. Ft.
Made ground		5	5
[Alluvium] River-mud and peat		8½	13½
[River Drift] Sand and gravel		9	22½
Blue [London] Clay		48½	71
[Woolwich and Reading Beds.]	Shelly beds	3½	74½
	Coloured [mottled] clays ...	18½	93
	Green sandy marls and pebbles	3	96
	Hard white stone and marl ...	2	98
	Green sand, pebbles and shells	10	108
	Dark grey sand and shelly rock	11	119
	Light-grey sand...	2¾	121¾
	Dark grey sand and pebbles ...	3¼	125
	Light-grey sand	31	156
	Green-coated flints	1	157
[Upper] Chalk		56	213

For details of the following Walthamstow wells, see the 'Memoir on London Wells,' by G. Barrow, 1912, pp. 107, 108.

Walthamstow, cont.

7. Electric Power Station, Priory Avenue (close to station). 1903.
70 ft. above Ordnance Datum.
Water-level 31 ft. below O.D. In 1911, 45 ft. below, at rest, 60 ft. when pumping. Supply 12,000 gallons an hour.

	Thickness. Ft.	Depth. Ft.
River Gravel	10	10
London Clay	108	118
? Blackheath Beds, Reading Beds and Thanet Sand	89 or 94	207 or 212
Upper Chalk	193 or 188	400

For analysis of the water, see p. 455.

8. Clifford Road. Houghton's Photographic Works. 1907.
85 ft. above Ordnance Datum.
Water-level 20 ft. below O.D. Yield 1,700 gallons an hour (7,000 an hour, May, 1909. J. C. T.).

Made earth and London Clay ...	115	350 ft.
Woolwich Beds and Thanet Sand ...	87	
Upper Chalk	147	

For analysis of the water, see p. 455.

9. Ferry Lane, close to the Lea. East London Water Co., now Metropolitan Water Board. 1903.
25 ft. above Ordnance Datum.
Shaft throughout with 4,362 ft. of headings at 169 ft. below O.D.
15 borings in the headings.

	Thickness. Ft.	Depth. Ft.
River Gravel	18	18
London Clay	36	54
Woolwich Beds and Thanet Sand ...	87	141
Upper Chalk	63	204

Walton on the Naze or Walton-le-Soken.

Ordnance Map 224, new ser. (Essex 39, NE.). Geologic Map 48, SE.

1. East Terrace, at the back of. 1882.
About 3 ft. above high water of spring tides.
Communicated by Messrs. J. Warner and Sons.
Old shaft 20 ft., the rest bored.

Water first got at 60 ft., and it rose to 4 ft. in the shaft. At 140 ft. the supply was somewhat increased, and rose another foot. The water-level varies about 3 ft., with the tide. The Chalk, to the depth of about 20 ft., very soft and saturated with water, and it yielded water more or less throughout.

		Thickness. Ft.	Depth. Ft.
Brickearth (and soil)		? 8 (or less ?)	8
[London Clay, ? 99 ft.]	Dark clay, a foot shingly at 25 feet ...	27	35
	Light-coloured sandy clay	1	36
	Dark clay, with layer of septaria and layer of cement-stone	24	60
	Grey sand with water (saltish, rose 4 ft. in well)	3	63
	Dark clay, with a foot layer of flint pebbles at 70 ft., fragment of bivalve at 80 ft.	44	107

Walton, cont.

		Thickness. Ft.	Depth. Ft.
[Reading Beds, 23 ft.]	Light-coloured mottled clay	2	109
	Light-coloured loamy clay	6	115
	Light-coloured mottled clay	3	118
	Dark brown sandy clay	4	122
	Greenish sandy clay	1	123
	Dark brown mottled clay	2	125
	Dark brown clay	1	186
	Greenish mottled clay	4	130
[Upper Chalk, 240 ft.]	Grey discoloured chalk with layers of flints	2	132
	Soft white chalk with occasional flints	238	370

2. The following MS. note, by the late John Brown (of Stanway), may refer to the well made for the late Mr. Warner, of which Messrs. Warner have no account, except that it was 350 ft. deep, and in the garden of No. 1, East Terrace. On a drawing of the coast-section, which this note accompanied, it is stated that the Chalk 'had been reached by boring at 130 ft.' For note and drawing we are indebted to H. B. Woodward.

		Thickness. Ft.	Depth. Ft.
[? Alluvium and Brickearth, 26 ft.]	Blue clay, with vegetables and remains of goat	4	4
	Oysters, *Buccinum undatum*, *Trochi*, *Mytilus* [a bed of shells]	2	6
	Till with fossil mammalia	20	26
London Clay [including Reading Beds]		100	126
To Upper Chalk, with Foraminifera...			

3. Waterworks, close to and below the Railway Station. 1858? (to 120 ft.), deepened 1868.

From specimens at the Waterworks.

Surface 48 ft. above low-water mark. Shaft 60 ft., the rest bored.

Water 40 ft. down, hardly affected by pumping. It got brackish and the well was abandoned.

		Ft.
[London Clay, 116 to 120 ft.]	Cement-stone	at 92
	Sandy clay	,, 107
	[Basement-bed.] Black flint pebbles in fine brown sand (clayey ?) ...	,, 115
	[Basement-bed.] Smaller black flint pebbles (in hard brown clay ?) ...	,, 116
[Reading Beds, 57 to 61 ft.]	Brownish clay	,, 120
	Red mottled sandy clay	,, 123
	Brownish clay	,, 126
	Specimens missing (said to be clays) ...	,, 128 & 132
	Brownish clay	,, 150
	Very sandy buff clay	,, 154
	Sandy clay	,, 156
	Buff clayey sand	,, 157
	Grey sand, less clayey	,, 158
	Grey clayey sand, streaked with red ...	,, 159 & 161
	Red clay and greenish-grey clayey sand, mixed	,, 163
	Red clay with a little calcareous earth ...	,, 164 & 165
	Red and grey mottled clay	,, 171
	Grey clay, mottled with brown	,, 172
	[Bottom-bed] green-coated flints in very clayey green sand	,, 176
[Upper Chalk]	Flints (a bed of about 18 ins., some green)	,, 177 & 178
	Chalk. Within 30 ft. of the bottom, flints here and there (from which the water came), but not so many as in the top part	,, 200 to 400

The supply of Walton now comes from the Tendring Hundred Co., but the outlying parts depend on shallow wells. (Dr. THRESH's Report of 1901, p. 124.)

Wanstead.

Ordnance Map 257, new ser. Geologic Maps 1, SW., London District, Sheet 2.

Red Bridge, close to the Roding. East London Water Co., now Metropolitan Water Board. 1904.

For details, see 'Memoir on London Wells,' by G. BARROW, 1912.

Shaft 5 ft. into the Chalk, with 1,518 ft. of headings at 154 ft. below Ordnance Datum. Water-level in 1911 about 45 ft. below O.D. Yield about 2,000,000 gallons a day. For an analysis of the water, see p. 407.

	Thickness. Ft.	Depth. Ft.
Gravel	14	14
? London Clay	39	53
Woolwich Beds and Thanet Sand ...	87	140
Upper Chalk	about 60	200

Warley, see Great and Little Warley.

Weeley.

Ordnance Map 224, new ser. (Essex 38). Geologic Map 48, SW.

The following old record, given as for Weeley, must refer to Warley. Barracks.

Rev. W. B. CLARKE, *Trans. Geol. Soc.*, ser. 2, vol. v, p. 369.

Water rose instantly and stood 50 ft. deep.

Gravel	20	146 ft.
London Clay, with septaria, to sand [Reading Beds]	126	

Dr. THRESH says that in parts of the parish it is impossible to get water. There are a few shallow wells. The owners of three cottages only have applied for a supply from the Tendring Hundred Co. (1913).

Wendens Ambo or Wenden.

Ordnance Map 222, new ser. (Essex 8). Geologic Map 47.

1. Lord Braybrooke's cottages, on the southern side of the road, a little north of Audley End Railway Station. 1886.

About 230 ft. above Ordnance Datum. (? 228.)

Made and communicated by Mr. G. INGOLD.

Shaft 50 ft., the rest bored.

Water rose to 60 ft. from the surface.

		Thickness. Ft.	Depth. Ft.
[? Post Glacial Drift.]	Gravel	2	2
	Brown sandy loam	8	10
	Gravel	14	24
[Glacial Drift, 272 ft.]	Chalky clay	3	27
	Sand	4	31
	Gravel	5	36
	Sand	4	40
	Gravel	3	43
	Sand	1	44
	Gravel	2	46
	Hard yellow loamy sand	9	55
	Blue chalky clay	6	61
	Brown clay	2	63
	Blue loam	3	66
	Brown loam	2	68
	Blue loam	2	70

Wenden, cont.

		Thickness. Ft.	Depth. Ft.
[Glacial Drift, 272 ft.]	Slate-coloured sandy loam [specimen, at 173, pale grey, calcareous] ...	110	180
	Ditto, with more sand [specimen, at 200, compact pale-grey calcareous sand]	51	231
	Blue Boulder Clay, with chalk stones	5	236
	Slate-coloured sandy loam, [specimen, at 248, pale grey, calcareous] ...	13	249
	Yellowish-brown clay	1	250
	Light-brown sand	4	254
	Yellow loam [specimen, at 259, mottled with grey, calcareous]	12	266
	Blue loam	2	268
	Blue sandy loam	9	277
	Hard blue Boulder Clay, with chalk-stones	18	295
	Brown clay	1	296
Chalk, with flint	... ...	53	349

The great depth of the hollow of Drift here is notable. Mr. Ingold informs me that by the railway-embankment at a distance of only 140 yds. northward, the Chalk is found at 3 ft. from the surface; so that the fall of the surface of the Chalk is 293 ft. in 420; but to this must be added 6 ft. for the slight difference in level between the site of the well and the spot by the embankment, making 299, or say 300, in 420, or 5 in 7.

This well is used for public supply.

2. Mr. T. Collins'. 200 yds. east-north-east of Audley End Railway Station. 218 ft. above Ordnance Datum.

Communicated by Mr. G. Ingold, well-sinker.

Shaft 55 ft., the rest bored.

Slow spring. 8 to 9 ft. of water in the shaft.

		Thickness. Ft.	Depth. Ft.
[Post-Glacial] Gravel	... ...	10	10
[Glacial Drift, 210 ft.]	Fine laminated yellow sand ...	45	55
	Dark grey sand	165	220
Chalk ...	... ...	50	270

Another account describes the bed above the Chalk as bluish clayey sand, and white marly stuff.

This is a remarkable section, as the Chalk comes *to the surface* within 100 yds. in almost every direction.—W. H. Penning.

3. In field opposite Claverend Farm and on the southern side of the road at its junction with Duddenhoe Lane, 1⅛ miles south of west from the church.

Made and communicated by H. G. Featherby.

Nearly 208 ft. above Ordnance Datum.

Rest-level of water 19 ft. down, 12th April, 1910.

Boulder Clay ...	6	26 ft.
Chalk	20	

4. The Vicarage.

About 200 ft. above Ordnance Datum.

Well 39 ft. deep, the lower part in Chalk.

Wennington, see **Rainham** (Nos. 1, 7).

West Bergholt.

Ordnance Map 223, new ser. (Essex 27, NW., NE.). Geologic Map 48, SW.

Brewery. New boring. 1875.

Sunk and communicated by Messrs. S. F. BAKER and SONS, with further particulars from Messrs. DANIELL.

About 175 ft. above the sea by aneroid. [W. H. DALTON.]

Old shaft 147 ft., the rest bored.

Water stands about 128 ft. from the surface; its level is not lowered more than a foot by pumping 200 or 300 barrels an hour. The temperature averages 53°.

		Thickness. Ft.	Depth. Ft.
Gravel	...	13	13
[London Clay.]	Clay	137	150
	Sand	1	151
	White rock [septaria]	1½	152½
	Clay	23	175½
	Mottled clay with a few pebbles at the base	27	202½
[Reading Beds and Thanet Beds.]	Sand, green and very hard	16	218½
	Sand	41½	260
[Upper] Chalk	...	150	410

An older well gave the following section, according to a rough drawing at the Brewery.

Shaft 133 ft., the rest bored.

		Thickness. Ft.	Depth. Ft.
Gravel	...	13	13
London Clay	...	147	160
[Reading Beds, 70 ft. ?]	Spring [? sand]	5	165
	Clay	20	185
	Plastic clay	25	210
	Green sand	15	225
	Clay [specimen of dark grey loam at 230 ft.]	5	230
Chalk	...	223	453

For an analysis of the water from here, see p. 456.

According to Dr. J. W. COOK's Report for 1900, repeated in Dr. THRESH's Report of 1901, p. 132, and in his Report of 1905, p. 67, the parish was then supplied generally by shallow wells, and three public springs in the neighbourhood of the village had recently been protected and made usable.

West Donyland, see **Berechurch,** p. 94.

West Ham.

Ordnance Maps 256, 257, new ser. Geologic Maps 1, SW., and London District, Sheet 2.

1. Distillery. 1861.

Boring made and communicated by Messrs. T. DOCWRA and SON.

		Thickness. Ft.	Depth. Ft.
Gravel and sand	...	16	16
[?Lower London Tertiaries.]	Yellow clay	2	18
	Running sand	17	35
	Blue clay	2	37

2. Gasworks. On the south-eastern side of the high road, about half a mile westward of the church. 1891.

A boring, made and communicated by Messrs. DOCWRA.

Water-level $10\frac{1}{4}$ ft. down, July, 1891.

Yield so small as to lead to abandonment.

West Ham, cont.

		Thickness. Ft.	In.	Depth. Ft.	In.
Made ground		3	6	3	6
[Alluvium ?] Maiden ground		1	0	4	6
[River Drift, 13 ft.]	Ballast [gravel] and clay	2	6	7	0
	Clean ballast	10	6	17	6
[?London Clay.]	Blue clay and shells	5	0	22	6
	Shells	0	6	23	0
	Sand and pebbles	1	0	24	0
[? Woolwich Beds.]	Light-coloured clay	3	0	27	0
	Light-coloured sharp clay and sand	9	8	36	8
	Loamy clay	3	0	39	8
	Blue clay and shells	8	4	48	0
	Very hard loamy sand	4	0	52	0
	Hard rock	1	8	53	8
	Dark sand and clay	5	0	58	8
	Light-green sand	3	0	61	8
	Pebbles	2	10	64	6
	Green sand	8	0	72	6
	Dark sand and pebbles	8	6	81	0
	Pebbles	2	6	83	6
[Thanet Sand, 42½ ft.]	Very hard dark-green sand	3	0	86	6
	Light-green sand	39	0	125	6
	Flints	0	6	126	0
[Upper Chalk.]	Chalk	2	0	128	0
	Chalk and straggling flints. Water at 214 ft. A bed of flints, 2½ ft. thick, at 239 ft.	127	2	255	2

Where the Woolwich Beds end off seems uncertain.

3. Plaistow. Hudson's Wharf. Victoria Docks. Nitro-phosphate and Odams Chemical Manure Co.'s Works.
Communicated by G. AITCHISON, by Messrs. S. C. FOX and Co., and by C. P. PHILLIPS.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil		2	0	2	0
[Alluvium, 19 ft.]	Light-coloured clay	8	0	10	0
	Peat	8	6	18	6
	Dark clay	2	6	21	0
[River Drift] Ballast or gravel		13	0	34	0
Light [? London] Clay		36	0	70	0
[Woolwich Beds, 50 ft.]	Very fine sand *(? light-coloured)	1	0	71	0
	Sand and shells*	1	0	72	0
	Clay, iron-pyrites, and shells	1	0	73	0
	[Flint] pebbles	3	0	76	0
	Sand	15	0	91	0
	Clay and broken shells	8	0	99	0
	Dark stone	1	5	100	5
	Coloured stone	0	4	100	9
	White stone	1	9	102	6
	Shells and sand	1	0	103	6
	Green sand	13	0	116	6
	[Flint] pebbles in sand	3	6	120	0
[Thanet Sand, 53 ft.]	Dark sand	15	0	135	0
	Live sand	37	0	172	0
	Flints	1	0	173	0
[Upper] Chalk with flints		178	0	351	0

* [These two beds may belong to the basement-bed of the London Clay.]

Another version makes the depth to the Chalk 170½ feet. I hear, from Mr. C. P. PHILLIPS, that the well has been deepened, and that the water usually stands within a few feet of the surface, when the pumps are not working.

West Ham, cont.

4. Plaistow Wharf. Lyle and Co. 1883.
Made and communicated by Messrs. DOCWRA.
Bore of various diameters.

		Thickness. Ft.	Depth. Ft.
Bungham [? made ground or alluvium ?] ...		14	14
Ballast [gravel] ...		21½	35½
[London Clay, 15 ft.]	Blue clay ...	14	49½
	Black [flint] pebbles ...	1	50½
[Woolwich Beds, 39 ft.]	Dark sand ...	18½	69
	Blue clay, with shells ...	13	82
	Yellow clay ...	7½	89½
[Thanet Sand, 61½ ft.]	Light-green loamy sand ...	2	91½
	Loamy green sand ...	59½	151
[Upper and Middle] Chalk. 18-in. bed of flints at the depth of 310 ft., another at 396, and an 18-in. bed of hard chalk at 400 ...		484	635

Possibly some of the sand classed as Thanet may belong to the Woolwich Beds.

5. Plaistow. Messrs. Duncan Bell and Scott, Sugar Refiners, Clyde Wharf, near Victoria Docks. 1862.
Communicated by Messrs. S. F. BAKER and SONS.
Depth to Chalk 170 ft.

W. H. DALTON says that the Plaistow wells (3–5) are close together, Odams' place being close to the western entry of the Victoria Docks, Duncan's 50 yds. and Lyle's 130 yds. south of the entry; and that they show the rise of the Chalk toward the Deptford outcrop.

6. Mr. Tuckers. ? At the junction of Abbey Lane and Plaistow Lane, about half a mile south-south-east of Stratford Broadway.

PRESTWICH, *Quart. Journ. Geol. Soc.*, vol. x, p. 152. (The remarks in these brackets from a letter from Messrs. S. F. BAKER and SONS, who sank the well.)

		Thickness. Ft.	Depth. Ft.
Made ground ...		8	8
Black [River] gravel ...		9	17
Peaty [? London] Clay ...		16	33
Woolwich Beds, 42 ft.	Pebbles [? Blackheath Beds or basement-bed of the London Clay] ...	2	35
	Shelly ? clay ...	4	39
	Light-brown sand ...	18	57
	Clay and shells (clay and pebbles) ...	6	63
	Hard shells (hard rock) ...	5½	68½
	Green sand ...	1½	70
	Pebbles ...	5	75
Thanet Sand (fully charged with water) ...		57	132
[Upper] Chalk...		306	438

7. West Ham Abbey Marsh. Imperial Gasworks (now Gas Light and Coke Co.). Wrongly entered in the 'Geology of London,' vol. ii, p. 86, as in Bromley by Bow, in Middlesex. 1875.
6½ ft. above Ordnance Datum.
Sunk and communicated by Messrs. T. DOCWRA and SON.
Cylinders and shaft 52 ft., the rest bored, 24 in. diameter.
Water-level, when not pumping, 32 ft. down, after pumping, 52 ft.
In 1911, 59 ft. (? below Ordnance Datum). Yield 7,000 gallons an hour.

West Ham, cont.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil		5	2	5	2
Gravel		10	10	16	0
[London Clay, 38½ ft.]	London Clay	37	0	53	0
	Sand and pebbles [basement-bed]	1	6	54	6
[Woolwich and Reading Beds, 53 ft.]	Undescribed bed	0	6	55	0
	Sand	4	0	59	0
	Sandy clay	1	6	60	6
	Mottled clay	5	0	65	6
	Grey sand	8	0	73	6
	Blue clay with shells	9	0	82	6
	Mottled sand and clay	7	6	90	0
	Green sand and pebbles	17	6	107	6
[Thanet Sand, 47 ft.]	Green sand	46	0	153	6
	[Flints]	1	0	154	6
[Upper] Chalk.	Stinking water came in at 329½ ft. from the surface	345	6	500	0

In the 'Memoir on London Wells' the depth is given as 486 ft., that to the Chalk as 149.

For details of the following West Ham wells (Nos. 8–10) see Memoir on London Wells, 1912, pp. 109, 110. The classification of the beds sometimes differs.

8. Abbey Mills. Electric Power Station. 1898.
16 ft. above Ordnance Datum.
Water-level 34 ft. below O.D. Supply 6,000 gallons an hour.

	Thickness. Ft.	Depth. Ft.
Made ground and River Drift	16	16
London Clay	29	45
Woolwich Beds and Thanet Sand	92	137
Upper Chalk	314	451

9. Canning Town. Quadrant Street. Electric Power Station. 1898.
8 ft. above Ordnance Datum.
Water-level 26 ft. below O.D. Supply 10,500 gallons an hour.

	Thickness. Ft.	Depth. Ft.
Made ground and River Drift	20	20
London Clay	47	67
? Blackheath Beds, Woolwich Beds and Thanet Sand	101	168
Upper Chalk	232	400

10. Marshgate Lane. Charing Cross, etc., Electric Supply Corporation.
10 ft. above Ordnance Datum.
Water-level 80 ft. below O.D. Supply 16,000 gallons an hour.

	Thickness. Ft.	Depth. Ft.
Made ground and gravel	24	24
London Clay	17	41
Woolwich Beds and Thanet Sand	93	134
Upper Chalk	276	410

11. Stratford. Great Eastern Railway Co.'s Works. 1870.
About 14 ft. above Ordnance Datum.
Made and communicated by Messrs. S. C. Fox and Co.
Water-level, 1876, 2·9 ft. above Ordnance Datum; 1893, 4·1 ft. below Ordnance Datum, a loss of 7 ft. in 15 years.

West Ham, cont.

		Thickness. Ft.	Depth. Ft.
Soil and gravel [River Drift]		30	30
[Woolwich and Reading Beds, 36 ft.]	Marly clay	5	35
	Shells	1	36
	Pebbles	10	46
	Sand, pebbles, and oyster-shells	10	56
	Sand and a few pebbles	10	66
[Thanet Sand, 40 ft.]	Running sand	39	105
	Sand and clay	1	106
[Upper Chalk, 294 ft.]	Chalk and occasional thin layers of flints	50	156
	White flints	1	157
	Chalk and flints	28	185
	Hard black flints	1½	186½
	Chalk, with a very thin layer of sand at the bottom	2½	189
	Chalk and frequent layers of flints	87	276
	Black flints	4	280
	Chalk with flints in frequent layers	120	400

An account, from H. W. DAVIS, differs slightly, and gives the additional information that the shaft is 56 ft. deep (the rest bored). A newer well is noticed further on, see No. 20.

12. Stratford. Messrs. Howard and Sons' Chemical Works. High Street, about midway between Bow and Stratford. 1884.

Sunk and communicated by Messrs. LE GRAND and SUTCLIFF.

14 ft. above Ordnance Datum.

Shaft (or pit) 14 ft., the rest bored. Water-level 31 ft. down.

Supply over 40,000 gallons a day. Water very pure, and of uniform quality and temperature.

		Thickness. Ft.	In.	Depth. Ft.	In.
Made ground		8	0	8	0
Peaty loam		5	6	13	6
Blue [? London] Clay		2	6	16	0
[? Blackheath Beds, 13 ft.]	Small shells	3	0	19	0
	Black [flint] pebbles	10	0	29	0
[Woolwich and Reading Beds, 58 ft.]	Dark brown clay	4	6	33	6
	Dark brown sandy clay, with shells (? oysters)	5	0	38	6
	Dark clay	2	0	40	6
	Brown sandy clay	1	6	42	0
	Drab live sand, with thin bands of clay	12	0	54	0
	Light-coloured clay	1	0	55	0
	Dark clay, with shells	7	0	62	0
	Clay and limestone	2	10	64	10
	Mottled sandy clay	1	2	66	0
	Mottled sandy clay, with small black [flint] pebbles	1	6	67	6
	Light-coloured sandy clay, with pebbles	2	6	70	0
	Dark green sand	10	0	80	0
	Green sandy clay, with a few shells (oyster)	2	0	82	0
	Grey sandy clay and black [flint] pebbles	5	0	87	0
[Thanet Sand, 48½ ft.]	Live grey sand	40	0	127	0
	Dead grey sand	8	0	135	0
	Green flints	0	6	135	6
[Upper] Chalk and flints		114	6	250	0

13. Stratford. Messrs. Howard and Sons' Chemical Works. Second boring. 1885, 1886.

14 ft. above Ordnance Datum.

West Ham, cont.

Made and communicated by Messrs. LE GRAND and SUTCLIFF (to W.H. DALTON, who gives particulars of position).
60 ft. north and 572 west of St. Michael's Bridge. 308 ft. west of first well.
Water-level 33 ft. down, February, 1886.

		Thickness. Ft.	Depth. Ft.
Dug well		—	13
[River Drift.]	Sandy clay	3	16
	Ballast [gravel]	6	22
Blue [London] Clay, with 6 ins. septaria (?) at the base		12½	34½
[Woolwich and Reading Beds, 47½ ft.]	Coloured [mottled] clay	9½	44
	Light-coloured dead grey and brown sand and clay	6	50
	Blue clay and shells	12	62
	Coloured [mottled] sandy clay and stones	7½	69½
	Black pebbles	2	71½
	Grey sand and clay	7½	79
	Grey sand, clay, shells, and pebbles	3	82
[Thanet Sand, 52½ ft.]	Hard dark sand and clay	9	91
	Hard dead grey sand	43	134
	Flints	½	134½
[Upper] Chalk and flints		117	251½

For an analysis of water from Messrs. Howards' (one of the above wells), see p. 457.

14. Stratford. Langthorn Chemical Works (opposite the Abbey Mills Sewage Pumping Station). 1850. Works closed.
15 ft. above Ordnance Datum.
From a drawing in Messrs. DUNN's Office.
Shaft 60 ft. (brick 4 ft., iron cylinders 56 ft.). Supply abundant.

		Thickness. Ft.	Depth. Ft.
Made earth		19	19
[? Woolwich Beds and Thanet Beds.]	Clay, with sand and little water	42	61
	Shelly rock	2½	63½
	Sand, with pebbles, strongly charged with water	68½	132
[Upper] Chalk		323	455

15. Stratford. Phoenix Black Works, Abbey Mills. 1888.
Bored and communicated by Messrs. LE GRAND and SUTCLIFF.
Water-level 26½ ft. down in Dec., 1888.

		Thickness. Ft.	Depth. Ft.
Soil		3	3
[River-Drift, 9 ft.]	Red loamy sand and gravel	5	8
	River ballast [gravel]	4	12
[London Clay, 24 ft.]	Yellow clay	1	13
	Blue clay	23	36
[Woolwich and Reading Beds, 50 ft.]	Blue sandy clay and pebbles	4	40
	Blue sandy clay and shells	4	44
	Grey sandy clay and shells	6	50
	Brown sandy clay	2	52
	Light-coloured clay and shells	4	56
	Dark clay and shells	6	62
	Coloured [mottled] sandy clay and pebbles	18	80
	Dark grey sand and clay, with small pebbles and shells	6	86
[Thanet Beds, 46¼ ft.]	Live, grey Thanet sand	41	127
	Grey sand and clay	4½	131½
	Green flints	¾	132¼
[Upper] Chalk and flints		67¾	200

West Ham, cont.

16. Stratford Brewery. Savill Brothers', Leytonstone Road.
30 ft. above Ordnance Datum.
Sunk and communicated by Messrs. T. Docwra and Sons.

Upper cellar-floor 3½ ft. above road (which is 7¾ above lower cellar-floor). Cylinders to 138 ft., up to 2½ ft. above lower cellar-floor. Bore deepened in 1892 to 525 ft.

Mean water-level 26¾ ft. down (? measured from top of cylinders). In 1893, 2 ft. below Ordnance Datum, a loss of 6 ft. in 26 years.

			Thickness. Ft.	Depth. Ft.
Made ground, etc.			7	7
Coarse [River] gravel			5	12
[London Clay ? 3½ ft.]	Yellow clay		1	13
	Blue clay		2½	15½
[Woolwich Beds, 33 ft.]	Loose red or light-yellow sand		3	18½
	Dark firm sand and shells		16	34½
	[Bottom-bed.]	Green sand	3	37½
		Large pebbles (and green sand ?)	12	49½
[Thanet Sand]	Grey sand (water)		56	105½
	Large green pebbles [green-coated flints]		53	108½
Chalk			416½	525

Perhaps there may be no London Clay here, and the clay may belong to the Woolwich Beds.

In Sir J. Prestwich's MSS. is a note of an old well at Stratford Brewery, giving 35 ft. of gravel and 247 into Tertiary sand, ending in blue and green sand. The water rose to 30 ft. from the surface. There would seem to be some error if the site be the same as the above.

17. Stratford. 6 Temple Mill Lane. Messrs. Clay & Co.
Bored and communicated by Messrs. Isler & Co.
Water-level 19 ft. down. Supply 1,000 gallons an hour.

		Thickness. Ft.	Depth. Ft.
Dug well (ballast), the rest a bore of 4 ins. diameter		—	14
[Woolwich Beds, 37 ft.]	Blue clay	12	26
	Green sand and clay	13	39
	Fine dark sand	5	44
	Shingle and sand	7	51
[Thanet Sand.]	Fine sand	3	54
	Blowing sand	44	98
[Upper] Chalk and flints		166½	264½

For details of the following Stratford wells, see the 'Memoir on London Wells,' by G. Barrow, 1912, pp. 103–107. The classification differs in places:—

18. Messrs. Boake & Co. Carpenters Road (? Row), near the Canal. 1907.
15 ft. above Ordnance Datum.
Water-level 49 ft. below O.D. Supply 8,000 gallons an hour

Made ground and River Drift	23½	350 ft.
Woolwich Beds and Thanet Sand	89½	
Upper Chalk	237	

19. Sugar and Malt Products Co. Carpenters Road. 1910.
13 ft. above Ordnance Datum.
Water-level 52 ft. below O.D. Supply 14,000 gallons an hour.

Made ground and River Drift	17	349 ft.
Woolwich Beds and Thanet Sand	90	
Upper Chalk	234	

West Ham, cont.

20. Great Eastern Railway Works. Newer well. 1908.
17 ft. above Ordnance Datum.
Water-level 27 ft. below O.D. (Falling to 103 on pumping. J. C. T., 1909.)
Supply 12,624 gallons an hour. (10,000 gallons. J. C. T., 1909.)

Made ground and gravel	17	400 ft.
Woolwich Beds and Thanet Sand ...	88	
Upper Chalk	294	

For analysis of the water (?of this well), see p. 457.

21. Romford Road, No. 141. Essex Steam Laundry (Tillett's). 1908.
30 ft. above Ordnance Datum.
Water-level 20 ft. below O.D. Supply 6,000 gallons an hour.

	Thickness. Ft.	Depth. Ft.
Made ground and River Drift ...	23	23
London Clay	17	40
Woolwich Beds and Thanet Sand ...	79	119
Upper Chalk	181	300

22. Romford Road, No. 242. Reeves' Brewery, now Pianoforte Factory. 1897.
35 ft. above Ordnance Datum.
Water-level 5 ft. above O.D. Supply 4,200 gallons an hour.

Well and River Gravel	22	250 ft.
Woolwich Beds and Thanet Sand ...	82	
Upper Chalk	146	

23. Romford Road, No. 330. Sunnyside Laundry, Messrs. Harvey. 1910.
35 ft. above Ordnance Datum.
Water-level 13 ft. below O.D. Supply 2,800 gallons an hour.

River Gravel	28½	250 ft.
Woolwich Beds and Thanet Sand ...	70	
Upper Chalk	151½	

24. Messrs. Roberts' Stores. Broadway. 1896.
26 ft. above Ordnance Datum.
Water-level 7 ft. below O.D. in 1896, 28½ ft. in 1906, and 55 ft. in 1911.
Yield 1,800 gallons an hour.

Pit, Woolwich Beds and Thanet Sand	120	271 ft.
Upper Chalk	151	

25. Forest Gate Laundry. Upton Road. 1897.
35 ft. above Ordnance Datum.
Water-level 8 ft. above O.D. Supply 3,500 gallons an hour.

Well (gravel and sand, 28 ft.) Woolwich Beds and Thanet Sand	105½	250 ft.
Upper Chalk	144½	

For analysis of the water, see p. 457.

The Stratford wells 11, 12 ?, 14, 16 ?, 17–20, 22–25 are in the part where, from uprise of the beds, the London Clay has been eroded.

West Hanningfield.

Ordnance Map 241, new ser. (Essex 61, NW.). Geologic Map 1, NE.
Rectory. 1802.

Extract from the Parish Register, communicated by R. H. TIDDEMAN.
"The well at the west end of the new Parsonage was begun Feb. 28th, 1802, and finished Sept. 5th following. Depth 461 feet and upon boring through the Rock the water gush'd in immediately and rose 212 feet within two hours. Thos. Brooksby, M.A., Rector."

West Hanningfield, cont.

The water is said to have been good, but, owing to the sides of the well giving way, a later rector filled it up, fearing it would endanger the stability of the rectory.

The following account, from a record in the Chelmsford Museum, differs but little from the above:—

Sand reached, and water broke in, at a depth of 462 ft.

Water rose 213 ft. in $2\frac{1}{2}$ hours.

According to Dr. THRESH's Report of 1901, p. 104, a well at the Compasses has water with over an ounce of saline matter to the gallon, chiefly Epsom Salts.

West Horndon.

Ordnance Map 257 (Essex 67, SE., 75, NE.). Geologic Map 1, NW.
The name does not occur on the old map.

According to Dr. THRESH's Report of 1901, p. 85, some of the cottages were supplied by the South Essex Co. and the rest got their water from shallow wells.

West Mersea.

Ordnance Map 257 (Essex 67, SE., 75, NE.). Geologic Map 1, NW.

Geologic Map 48, SW.

From the *Essex County Standard*, 25th April, 1908.

Many of the houses "in the vicinity of the Hard and the Square have to obtain water from St. Peter's well, while the group about the Lane draws from a tank filled from a well upland."

"Recently two wells have been sunk on the west side of the island, and in both cases the men failed in finding water before reaching the London clay . . . borings were continued through the London clay . and on penetrating this, and reaching the chalk . . water was tapped and rose to within a score or so of feet from the surface."

1. New Victory Inn. 1908.

Well and 4-in. boring. Made and communicated by Mr. H. C. SMITH.

Water-level $14\frac{1}{2}$ ft. down.

Pumping 1,500 gallons an hour only lowered water-level by $3\frac{1}{2}$ ft.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Dug well, the rest bored	—	45
	Clay	95	140
[? Lower London Tertiaries.]	Light-blue sandy clay	30	170
	Live green sand... ...	20	190
	Grey sand	35	225
	Dark blue clay	7	232
	Dark green sand ...	$1\frac{1}{2}$	$233\frac{1}{2}$
	Flints	$\frac{1}{2}$	234
[Upper] Chalk	... ...	66	300

For an analysis of the water, see p. 458.

2. Creek Hall.

Information from Dr. COOK, Medical Officer.

Recently (June, 1909) bored or reshelled; said to be over 300 ft. deep (?230) 30 being in Chalk. For an analysis of the water, see p. 458.

3. Waldegraves Farm.

Information from Dr. COOK.

50 ft. above Ordnance Datum.

Shaft 92 ft. deep, with a boring into the Chalk.

Water yellowish and evidently impure. For analysis, see p. 458.

West Mersea, cont.

4. Waldegraves Cottages.

6-in. boring, made and communicated by Mr. H. C. SMITH.

Yielding very different water from the well at Waldegraves Farm, see p. 458.

Dr. J. W. COOK, in his Report for 1900, repeated in Dr. THRESH's Report of 1901, p. 135, says that shallow wells were then the source of supply. There is a grand natural supply coming out of the bed of gravel on which the village stands, with three excellent springs, which supply it was suggested might be used.

Dr. COOK says (1913) that the spring on the cliff, called St. Peter's Well, is now a doubtful source.

West Thurrock.

Ordnance Map 271, new ser. (Essex 83). Geologic Maps 1, SW., and London District, Sheet 4.

1. Purfleet. Messrs. Bernays.

Made and communicated (1901) by Messrs. ISLER and Co.

Water-level 12 ft. down.

[Alluvium.]	Clay and peat ...	3	40 ft.
	Peat	25	
[River Gravel.]	Ballast ...	12	

2. Purfleet. Pure Oil Co. 1904. On the marsh about 100 yds. from the bank of the Thames, a quarter of a mile below the Thames Paper Mills. East-south-east from Purfleet Railway Station.

Made and communicated by Messrs. DUKE and OCKENDEN.

In the first instance bored and cased to 64 ft. Plenty of water found; but it was salt.

Boring continued, and a second casing-tube taken to the depth of 213 ft. This shut off all the top water, and none other was found to that depth, nor later to 276 ft. Tubes cut at 376 ft. and pulled up to 364, when a length of perforated tube was inserted.

Head of water overflowed periodically. Yield 300 gallons an hour.

	Thickness. Ft.	Depth. Ft.
Alluvium. Bog and clay ...	24	24
[River Drift] Sand and gravel	29½	53½
Chalk and flints	474½	528

3. Purfleet. Tank Storage Co.

Made and communicated by Messrs. ISLER and Co.

Well 2½ ft., the rest bored. Lined with 60 ft. of 4-in. tubes from 2 ft. down. Water-level 3 ft. down Supply 700 gallons an hour.

		Thickness. Ft.	Depth. Ft.
[? Alluvium.]	Top soil	1	1
	Brown clay	1½	2½
[River Gravel.]	Gravel	30	32½
	Thames ballast [gravel]	7½	40
	Gravel	10	50
[Upper] Chalk	... ...	50	100

4. Purfleet. Thames Paper Mills, formerly St. Louis Park Mills. On the marsh less than half a mile east-south-eastward of Purfleet Railway-station.

Five wells. ? About 10 ft. above Ordnance Datum.

West Thurrock, cont.

No. 1. Close to the railway at the eastern end of the grounds. 1886. Made and communicated by Messrs. LE GRAND and SUTCLIFF.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Peat and clay	11	11
	Peat and wood ...	6	17
	River ooze [marsh-clay]	12	29
[River Drift] Sand and gravel		21	50
[Upper] Chalk and flints		202	252

Information from E. REED (Manager) differs slightly, making: Soil, 4 ft.; peat and clay, 9 ft. The yield was 10,000 gallons an hour. The water was salt, and its hardness 40°.

No. 2. Near the railway, at the western end of the Company's land.
Communicated by E. REED, manager.
About 20,000 gallons of water [? per hour] got at full tide, less at low tide.

		Thickness. Ft.	Depth. Ft.
Soil		1	1
[Alluvium, 29 ft.]	Peat and clay	9½	10½
	Ooze and mud	19½	30
Ballast [River Gravel]		20	50
Chalk, with salt water		200	250

Nos. 3-5 made and communicated by Mr. R. D. BATCHELOR, with some additions from Mr. REED.

No. 3. About half way between Nos. 1 and 2. 1891.

At 243 ft., 5 gallons of water a minute, and little salt. Boring tested, at 268 ft., 6 gallons a minute; at 368 ft., about 90 gallons an hour; at 410 ft., about 180 gallons an hour; at 443 ft., about 30 gallons a minute, and salt. Mr. REED notes that 1,200 gallons of fresh water an hour were got; that salt water was got in the first 200 ft. of chalk, and fresh water in the last 100.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	River mud	14	14
	Peat	13	27
[River Drift, 26 ft.]	Gravel	16	43
	Gravel and chalk	10	53
[Upper (and ? Middle) Chalk, 401 ft.]	Chalk and flints, with a foot of rock 128 ft. down	144	197
	Chalk and flints, very hard; a layer of dark chalk at 243 ft.	53	250
	Chalk, the bottom 3 ft. hard	17	267
	Sticky chalk, no flints	130	397
	Hard chalk	43	440
	Rock chalk	14	454

No. 4. Just east of the entrance-road and just south of the high road. 1892.

Pumped, with a pump of 7 in. diameter, for four or five hours, at the rate of 20,000 gallons an hour. Mr. REED says that the bulk of the water came (in this and in No. 5) from between 50 and 75 ft. down, from a bed of flints, and that the water was fresh and good.

		Thickness. Ft.	Depth. Ft.
[Alluvium] Clay		10	10
[Upper Chalk.]	Chalk and flints...	33	43
	Flints. Did not need shelling out: the stuff vanished somewhere, must be a pot-hole	17	60
	Chalk and flints	5	112

West Thurrock, cont.

No. 5. Close to No. 4. 1892.

Tested, with a pump of 7 in. diameter, at the rate of 101,000 gallons an hour, lowering the water-level 10 ft. Mr. REED notes merely a trifle less, 2,422,224 gallons a day of twenty-four hours. There must be some mistake in these figures, as no 7-in. pump can deliver such a quantity. Water fresh; hardness 38·7°.

[Alluvium.]	Clay ...	6	130 ft.
	Peat ...	3	
[Upper] Chalk and flints ...		121	

For an analysis of the water from here, see p. 459.

5. Tunnel Cement Works. 1876.

Made and communicated by Messrs. LE GRAND and SUTCLIFF.

Water-level 10 ft. down.

? Yield 220,000 gallons a day, of ten hours, from two tube-wells.

Chalk and flints, 71 ft.

6. On the marsh, about 250 ft. from the sea-well, in a line with the 'Fox and Goose' on the north, and north-west from the lighthouse.

Communicated by the Rev. J. W. HAYES.

		Thickness. Ft.	Depth. Ft.
Marsh alluvial clay		38	38
Grey Thames ballast [Gravel]		14	52
[Upper Chalk.]	Soft chalk	96	148
	Hard chalk (highly silicious) ...	3	151
	Soft chalk reached	3	154

The soft chalk above the hard band yielded brackish water; a good supply of fresh water from the last bed.

About 5 per cent. of the houses of West and Little Thurrock are supplied by private wells, the rest by the South Essex Co.

West Tilbury.

Ordnance Map 271, new ser. (Essex 84, SW., 89, NW.). Geologic Map 1, SE.

1. Mr. Coles' cottages, on rising ground north of Low Street Station. 1885.

Made and communicated by Mr. G. INGOLD.

Shaft 25 ft., the rest bored. Water-level 31 ft. down. Strong spring.

For an analysis of the water, see p. 459.

		Thickness. Ft.	Depth. Ft.
Made earth or mould		2	2
[? River Drift.]	Gravel and sand	14½	16½
	Sandy loam	21	37½
	Stones	2½	40
[? Base of Thanet Beds.]	Blue clay, hard layer at bottom	9	49
Upper Chalk, with a layer of flints, 51 ft. down		16	65

2. Field at back of new cottages, next the public-house, north of the church. 1887.

Made and communicated by Mr. G. INGOLD.

Water-level 56 ft. down.

	Thickness. Ft.	Depth. Ft.
Mould	1	1
Gravel	3	4
Loamy sand	7	11
Brownish-grey [? Thanet] sand ...	50	61

West Tilbury, cont.

3. Tilbury Fort. Old well.
Gentleman's Magazine, vol. lxviii, p. 565 (1798).
Dug 48 ft., the rest bored.

Dry earth [made ground ?], thin.
[Alluvium] Clayey beds, with leaves and branches of trees, about 48 ft.
Quicksand.
Stiff marl, ? 30 ft.
Chalk-stones found at a depth of about 80 ft.

4. Tilbury Fort. Newer well. 1849.
Communicated by Col. E. M. Grain, R.E. With further information from Col. Brine, R.E.
Shaft and cylinders 31 ft., the rest bored.

Water, March 22nd, 1849, good; April 19th, impure; May 25th, good; since become quite unfit for domestic purposes (although pipes were carried to a depth of 490 ft.).

		Thickness. Ft.	Depth. Ft.
Made ground	...	3	3
[Alluvium, 41 ft.]	Strong mud or blue clay	$11\frac{1}{2}$	$14\frac{1}{2}$
	Peat with clay	$5\frac{1}{2}$	20
	Clay	3	23
	Dark peat	8	31
	Stiff clay	8	39
	Dark peat	5	44
[River Drift, $23\frac{1}{2}$ ft.]	Dark, sharp sand	7	51
	Sharp sand and gravel	4	55
	Light-coloured sharp sand and gravel	$12\frac{1}{2}$	$67\frac{1}{2}$
Chalk	...	517	$584\frac{1}{2}$

5. Messrs. Fletcher and Fearnall, Marine Engineers. Near the Docks. 1887.
Made and communicated by Messrs. Le Grand and Sutcliff.

[Alluvium and River Drift.]	Clay, peat, sand and gravel	10	130 ft.
	Soil	66	
Chalk and flints	...	54	

Wethersfield.

Ordnance Map 223, new ser. (Essex 15, NE., SE., 16, NW., SW.).
Geologic Map 47.

Dr. W. W. E. Fletcher, in his Report to the Local Government Board, No. 244, 1906, p. 10, says that at Wethersfield the water is got 'from wells, all furnished with pumps'; so that they must be shallow wells, in Glacial Gravel. There was one public pump in 1905.

White Colne.

Ordnance Map 223, new ser. (Essex 17, SE., NE.). Geologic Map 47.

According to Dr. Thresh's Report of 1901, p. 121, and of 1905, p. 66, there was no public well; but one private well yielded an unlimited supply of good water. A few people used a spring.

H. O. Cross (Sanitary Inspector) tells us later that this private well belongs to the cottages facing Colne Ford Hill. It is about 60 ft. deep, in clay. A lateral spring breaks in. A number of houses in the Colchester Road take water from this well, some being in Earl's Colne.

White Roding or Roothing.

Ordnance Map 240, new ser. (Essex 32, SW., 42, NW.). Geologic Map 47.
Two wells. Made and communicated by Mr. Ingold.

1. The School. 1874.
200 gallons of water in twenty-four hours.

White clay ...	18	25 ft.
Grey clay ...	7	

White Roding, contd.

2. Roadside, ½ mile north of village. 1876.
Shaft 84 ft., the rest bored. Water 77 ft. down.

White and blue boulder clay ...	88	90 ft.
Gravel	2	

Wicken Bonhunt or Bonnett.

Ordnance Map 222, new ser. (Essex 8, SE., 13, NE.). Geologic Map 47.

1. The Rectory. 2. Hall Farm.
Information from Mr. Watson, of Bishop's Stortford, with later information from W. B. Bliss.

1. Water-level 47 ft. down (1912). Yield, say 600 gallons a day (1912).

	1. Ft.	2. Ft.
Boulder Clay ...	18	40
Gravel and sand ...	20	20
To Chalk ...	38	60

For analyses of the waters from the Rectory well and from other wells in the parish, see pp. 460, 461.

In 1901 there were 110 houses and 15 private wells.

According to the Report of the Medical Officer for 1912, there were three public pumps, getting water from wells in Chalk.

Wickford.

Ordnance Map 258, new ser. (Essex 69, NW., SW.). Geologic Map 1, NE.

1. Mr. H. Wilmer, of the Great Eastern Railway, wrote, in 1901, that there is a well here (near the station) 335 ft. deep, and that it failed during the recent dry summer. This was made for public supply. According to Dr. Thresh's Report of 1901, pp. 81, 85, the water-level had fallen 29 ft. in 65 years; but the rate of fall had been much greater in recent years. The supply was 1,000 gallons in 24 hours. The Railway Co. and a few houses were supplied from the Danbury Waterworks.

2. Beeches. Just west of church. Old well.
Information from Mr. Purkis, the sinker, to W. H. Dalton

London Clay ...	225	265 ft.
Sand, to water ...	40	

3. Southend Water Co.'s No. 22, or Wickford Well. ¾ mile NE. of Wickford Church. 1911.

Communicated by E. C. Bilham, Engineer to the Company.
34·5 ft. above Ordnance Datum.
Sunk 347 ft., the rest an unlined boring.
Highest water-level 23½ ft. down. Lowest (pumping) 339½.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil		1	0	1	0
[London Clay.]	Clay and gravel ...	6	0	7	0
	Brown clay	12	6	19	6
	London Clay	342	0	361	6
[Oldhaven Beds ?]	Sand and pebbles ...	1	9	363	3

Water from sands of the Lower London Tertiaries.

Dr. Carter, M.O.H. of the Billericay Rural District, says that a well at the Castle inn was dug 17 ft. and bored 330; and that there are deep wells at English's and Bridge House (south of railway-station).

The village is now supplied by the Southend Co., and the supply from Danbury has been abandoned.

Wickham Bishops.

Ordnance Map 241, new ser. (Essex 45, SW.). Geologic Map 47.

1. Site of proposed 'Second Essex Asylum,' Heathgate Farm, south of Chancery Wood. 1878-1880.

Sunk and communicated by Messrs. EASTON and ANDERSON, and from specimens.

234 ft. above Ordnance Datum.

Shaft and cylinders 304 ft., the rest bored.

Dip of the beds about 18 in. in the outer diameter (6 ft. 8 in.), of the bottom part of the shaft=15°.

Yield, when drawn at a depth of about 80 ft. below sea-level, only about 10 gallons a minute.

		Thickness. Ft.	Depth. Ft.
Soil	...	1½	1½
[Glacial Drift, 41½ ft.]	Yellow clay	11½	13
	Sand and gravel, with surface-springs	30	43
[London Clay, 252 ft. Specimens of iron-pyrites (stems of plants) and of *Rostellaria* and bivalves in septaria.]	Blue clay	160	203
	Black clay	53	256
	Stiff black clay and cement-stones	19	275
	Running sand and septaria, with a strong spring of salt ferruginous calcareous water; fragments of shells found (according to a note from Mr. H. G. Dixon); 3 in. of black pebbles at bottom	20	295
[Woolwich and Reading Beds.]	Hard mottled blue and grey sand and clay	2½	297½
	Red and blue mottled clay [specimen, about 2 ft. down, of brown and grey mottled clayey sand; another, lower, as described]	14	311½
	Mottled red and grey clayey sand [specimen]	2	313½
	Fine sand	3¼	316¾
	Red and blue hard clay [specimen mottled brown and grey plastic clay], passing down into clayey greensand [specimen]	12¾	329½
[? London Clay, repeated by fault]	Yellow clay [specimen, brown sandy clay like London Clay]	2	331½
	Very stiff marly clay [specimen, mottled clay, partly sandy]	12	343½
	Very stiff silty loam [specimen, brownish grey]	7	350½
	Hard cement-stones [specimen with loam, as above]	1	351½
	Mottled silty clay [specimens, brown clay and sandy clay, with a bit of green sand, ? carried down by tool]	13¼	364¾
	Mottled clay and cement-stones [specimen, stone with shell, ? *Cardium laytoni*, ? basement-bed of London Clay]	5	369¾
	Silty clay and green sand [specimen, brown and green clayey sand, basement-bed?]	4	373¾
	Cement-stones [specimen like that from 5 ft. higher]	¾	374½
	Mottled clay [specimen, brown clay, partly sandy]	7½	382
	Sand and shells [specimen, ? basement-bed]	1	383

Wickham Bishops, cont.

		Thickness. Ft.	Depth. Ft.
[Woolwich and Reading Beds.]	Mottled clay and sand [specimen, clayey green sand, mottled red] ...	4?	387?
	Mottled clay [specimen, light-brown sandy clay]	7	394
	Hard reddish clay [specimen, red and grey mottled plastic clay]	5	399
	Red clay [specimen somewhat mottled clay, dark brown, partly sandy] ...	7?	406
	Hard sandy clay	5	411
	Light-coloured clay [specimen, pale green-grey sandy clay]	10	421
[Thanet Sand.]	Sandy loam	1	422
	Dark sandy loam [specimens, from top 20 ft., fine grey sand; from next 28 ft., fine grey sand, with green grains; from bottom 7 ft., fine grey sand.] About 4 in. of flints at base	55	477
[Upper Middle and ? Lower] Chalk, 703 ft.	Chalk, with flints	523	1,000
	Hard and compact chalk, with some flints in the upper part [specimen, white chalk with pale green-grey streaks]	46?	1,046
	Softer chalk	4?	1,050
	[Chalk]	130	1,180

Writing of this well, W. H. DALTON has said:—"Calculation from the nearest of previous wells showed that there was some local disturbance (in the neighbourhood). The Chalk surface descends from Braintree to Witham at the rate of 21·23 feet per mile, giving depth at Asylum of 495 feet whilst it rises from Maldon and Heybridge at 74 feet per mile, giving depth at Asylum of 194 feet."

Three explanations may be given, a gentle roll of the beds, a powerful undulation or reversal, a fault with northerly downthrow.

"The boring proved the last two of these . . to be combined."

"The base of the London Clay was met with at 295 feet, in the shaft, with a westerly dip of 18 in 68. Boring soon afterwards commenced in the Reading Beds, and at 343 feet a fault was passed, and the *London Clay reappeared.* Its base was again reached at 383. . . . The Reading and Thanet Beds must be inclined at high and varying angles, as at Witham (only two miles off) they are only 27 and 24 feet respectively."[1] See also p. 11.

It is the deepest boring for water in the county, the only one indeed over 1,100 ft. deep. Had I not seen specimens from the boring it would have been hard to make out the section. Perhaps the strong disturbance may have affected the water-yielding power of the Chalk, by squeezing the rock and closing up the fissures.

For an analysis of the water, see p. 461.

[1] *Trans. Epping Forest . Field Club*, 1882, vol. ii., pp. 16, 17, plate 1 (section).

2. In the bottom of the cutting southward of the railway-station. 1889.
Communicated by W. T. FOXLEE.

The well yields about 60,000 gallons in 24 hours. For an analysis of the water, see p. 461.

Well, about half way between the two bridges over the railway	7½ ft.	Through fine gravel to clay.
Boring, about half way between the well and the southern bridge	7 ,,	
Boring, less than half way from the well to the northern bridge	5½ ,,	

Wickham St. Paul.

Ordnance Map 223, new ser. Geologic Map 47.

According to Dr. THRESH's Reports of 1901, p. 139, and of 1905, p. 80, the place was chiefly supplied from a public well, yielding pure water. This had to be deepened in 1904.

It was 30 ft. deep, in clay and Chalk. There are several private supplies.

Wicks, see Wix.

Widdington.

Ordnance Map 222, new ser. (Essex 14, NW.). Geologic Map 47.

1. Ringers. Two-thirds of a mile east of Newport Railway Station.
About 315 ft. above Ordnance Datum.
From Mr. G. INGOLD.
Boulder clay, 45 ft.

2. Top of village. 1889.
Made and communicated by Mr. G. INGOLD.

[Boulder Clay.]	Brown clay	6	20 ft.
	Loose chalky clay, water water	14	

Wigborough, see Little Wigborough.

Willingate Spain.

Ordnance Map 240, new ser. (Essex 42, SE., 51, NE.). Geologic Map 1, NW.
Munson's Farm, about a mile south-west af the church. Old well.
Information from Mr. ROLFE, the sinker, to W. H. DALTON.

[Boulder Clay.]	White marl...	15 to 17	? 41 ft.
	Blue marl ...	35	

Wimbish.

Ordnance Map 222, new ser. (Essex 9). Geologic Map 47.

1. Elms Farm. $1\frac{3}{4}$ miles south-south-east of church. 1886.
Made and communicated by Mr. G. INGOLD.
Strong spring. Water-level 74 ft. down.

			Thickness. Ft.	Depth. Ft.
Mould ...			1	1
[Glacial Drift.]	[Boulder Clay.]	Blue-brown clay ...	19	20
		Blue clay	24	44
	Loamy sand ...		1	45
	Gravel and sand ...		7	52
	Gravel ...		24	76

2. Wiggall's Farm. 1884.
Made and communicated by Mr. G. INGOLD.

[Boulder Clay.]	Brown clay ...	13	21 ft.
	Blue clay	5	
	Loose clay (water)	3	

According to the Report of the Medical Officer for 1912 (and Dr. THRESH's Report for the same year), there are two public pumps, one (a windmill-pump) near the school, supplied from a deep well bored in 1912 through Boulder Clay into Chalk, the gift of Miss M. W. GIBSON, and one at Elder Street (? Wimbish Green) provided by Lord STRATHCONA, supplied by an enclosed spring.

Witham.

Ordnance Map 241, new ser. (Essex 34, SE., 35, SW., 44, NE., 45, NW.).
Geologic Map 47.

Dr. GREENHOW recorded many years ago (2 Rep. M.O.H. of Privy Council, 1860) that "the water supply is from wells, of good quality, but probably somewhat contaminated by percolation from cesspools." This condition of things has of course gone, from the establishment of a public supply.

1. Chipping Hill. Woolpack Inn, north of the churchyard.
Information from the sinker, Mr. J. CHALK.

	Thickness. Ft.	Depth. Ft.
Gravel	15 to 16	15½ ?
Boulder Clay ...	26	41½
London Clay	75	116½
Rock, to sand... ...	½	117

2. Powers Hall. More than a mile west-north-west of the town.
Information from Mr. HATLEY.
Water rose to 44 ft. below the surface.

[Glacial Drift.]	Boulder clay ...	20	250 ft.
	Sand and gravel ...	20	
London Clay.	To sand and water ...	210	

3. Railway Station.
Level of rails about 80 ft. above Ordnance Datum.
From a letter from J. DARBY to the Rev. O. Fisher, 1868.

[Post-Glacial Drift.]	Coarse gravel [in face of cutting] ...	about 70 ft.
	Sand	
	Mixed clay	
	Layer of chalk	
	Very hard coarse gravel	
[Glacial Drift.] with flints ...	Light-coloured clay, becoming blue clay	
[Eocene Tertiaries.]	Dove-coloured sand (less green sand than usual)	120 ft.
	A little red sand, no mottled or plastic clay	

If, as is possible, the bore-hole was dry, the London Clay might come up as what is here called "dove-coloured sand," and the water might be got, as in other wells near, from a bed *in* the London Clay.—Note from W. H. DALTON.

The account given by the Rev. O. FISHER, in *Geol. Mag.*, vol. v, pp. 98, 147, is as below. There seems to be a mistake in it, as both the London Clay and the Woolwich and Reading Beds must be present; these have perhaps been included in the 150 ft. ! of glacial clay. The depth to the Chalk is 100 ft. less than one would expect.

	ft.
Coarse gravel	20
Greyish glacial clay, with large flints and chalk-pebbles ...	150
Thanet Sand: fine, clayey, brown and green, with green-coated flints at bottom	10
To Chalk, and water ...	180

Witham, cont.

4. The Spa, three-quarters of a mile from the town, close to the avenue from Witham Place to the road to Faulkbourne.

J. TAVERNER. 'An Essay upon the Witham Spa,' pp. 2-4, 1737.

The spring-head 12 ft. lower than the ground around.

		Thickness. Ft.	Depth. Ft.
[Post Glacial Drift.]	Strong loam	about 4	4
	Strong loam with gravel	„ 3	7
	Gravel	„ 3	10
	Tough bed of lamellæ of different colours (2 in.). Gravel with sand, not bottomed	4	14

5. Mr. Blood's. A little north-east of the Water Tower and about a quarter of a mile southward of the Railway Station.

Boring made about 1856, 400 ft. deep. Water 15 in. down.

Information got in 1900.

6. Waterworks, on the left side of the Gwith just below the high road. 1869.

55·22 ft. above Ordnance Datum.

From a drawing in the Literary Institution, Witham (J. CHURCH, Engineer). Further information from Mr. T. TILLEY.

Shaft 60 ft., the rest bored.

Not much water, although the Chalk-spring overflowed at first.

Said to have yielded 70,000 to 80,000 gallons in 24 hours at first. Only 10,000 to 12,000 in 24 hours in 1899. The original figures are doubted, but there is a serious decrease.

		Thickness. Ft.	Depth. Ft.
Mould and made ground		3	3
[Drift, 66 ft.]	Coarse gravel	$11\frac{1}{2}$	$14\frac{1}{2}$
	Silt	$25\frac{1}{2}$	40
	Clay with chalk and small flints [Boulder Clay]	29	69
[London Clay, $154\frac{1}{2}$ ft.]	Sandy loam	2	71
	Blue clay	8	79
	Sandy loam	4	83
	Blue clay	7	90
	Sandy loam	$2\frac{1}{2}$	$92\frac{1}{2}$
	Hard blue clay	6	$98\frac{1}{2}$
	Silt clay and sand	12	$110\frac{1}{2}$
	Hard blue clay	60	$170\frac{1}{2}$
	Sandy loam	6	$176\frac{1}{2}$
	Blue clay	47	$223\frac{1}{2}$
[Reading Beds, 27 ft.]	Blue clay full of small flints	20	$243\frac{1}{2}$
	Black sand	4	$247\frac{1}{2}$
	Blue clay	3	$250\frac{1}{2}$
[Thanet Sand, 24 ft.]	Black sand	$20\frac{1}{2}$	271
	Green sand	3	274
	Flints	$\frac{1}{2}$	$274\frac{1}{2}$
[Upper] Chalk. At the bottom a bed of fine cream-coloured sand (specimen)		$225\frac{1}{2}$	500

Deepened later, see p. 316. For analyses of the water, see pp. 462, 463.

7. Newer Waterworks. Between road and railway, about 1,550 yds. north-north-west of Chipping Hill Church. 1902.

From specimens and information on the spot and from F. S. COURTNEY.

About 103 ft. above Ordnance Datum. First water at 480 ft.

Rest-level of water about 15 ft. down. Two days' pumping (at a depth of 275 ft.) at the rate of 6,000 gallons an hour. Later on, at greater depth, after 10 days' pumping, slightly over 10,000 gallons an hour was pumped. There was then some sand in the water (April, 1902).

Witham, cont.

		Thickness. Ft.	Depth. Ft.
[? Wash from Boulder Clay.]	Brown sandy clay and stones ...	1	1
	Brown sandy clay (more clayey than the above)	3	4
	Brown sandy clay	1	5
[Drift] Gravel...	... ...	$3\frac{1}{2}$	$8\frac{1}{2}$
London Clay, $206\frac{1}{2}$ ft.	Brown clay, rather mottled	3	$11\frac{1}{2}$
	Brown clay, darker lower down ...	$68\frac{1}{2}$	80
	Brown clay, a little sandy	10	90
	Brown clay, dark and greyish... ...	85	175
	Lighter-brown, rather sandy clay ...	10	185
	Brown sandy clay or clayey sand ...	10	195
	Brown sandy clay, of a brighter tint...	10	205
	Brown sandy clay	10	215
Reading Beds, 49 ft.	Dull brown sand	8	223
	Dull grey sand	5	228
	Mottled red green and grey sand ...	6	234
	Buff sand	4	238
	Dark greenish-grey hard clay ...	2	240
	Brownish-grey fine sand	20	260
	Green and brown mottled sand ...	4	264
Thanet Sand, 30 ft.	Brownish-grey fine compact sand ...	10	274
	,, ,, ,, firmer	10	284
	,, ,, ,, browner, green-coated flints at base	10	294
Upper Chalk and flints. Hard nodular chalk at 595 ft. Bottom part soft chalk		306	600

In a letter of April, 1905, J. M. Wood mentions that there was great trouble from incoming sand. He also says there are two bores, 12-in. and 15-in., both lined to 25 ft. into Chalk. For analyses, see pp. 462, 463.

The following remarks on Witham Waterworks are from the Report to the Local Government Board by Dr. R. J. Reece. No. 281, 1907:—

At the Old Waterworks, south of the town, the well and borehole went down to 536 ft. in 1868. The amount of water was so small that in 1871 the borehole was deepened 30 ft. The well was said to yield only some 10 gallons a minute, or 14,400 in 24 hours.

In 1872 the Council supplemented the supply by laying a main to springs north-west of the town, at Blunt's Hall Farm and 1,325 yds. from the old waterworks. From this source a further supply of 50,000 gallons in 24 hours can be got.

The *new* wells, about $1\frac{3}{4}$ miles north of Witham, are 16 ft. apart and 15 ft. deep, with borings to 600.

Lining pipes of 12 in. diameter were driven to $40\frac{1}{2}$ ft. into the Chalk. In September, 1904, sand practically blocked the boring of No. 1 well. Smaller tubes backed with cement were inserted from 330 ft. down for 150 ft. Sand still found its way into the well, but none appeared in No. 2, which, however, after being fitted with the inner steel lining failed to produce more than 1,100 gallons an hour. The pumps (200 ft. down) were raised 50 ft., and then little sand was pumped from No. 1 well, but no increase of water was got from No. 2.

"It is believed locally that the water in the bore holes is not derived from the Deep Chalk, but from the beds of Thanet Sand which overlie it, and that the water gravitates from these beds into fissures in the Chalk carrying with it sand."

Dr. Reece adds: "There are wells in use of the shallow type receiving surface water, and from the position of several of these wells it is manifest that they are liable to be seriously polluted. In the rural parts of the district the water supply is mainly from shallow wells."

The following information is from the Water Works Directory, 1911, pp. 395, 396:—Works established 1869. New works 1902-3. Population supplied, 3,500, Witham only. Two borings of 600 ft. Yearly supply, 25,174,510 gallons. Average daily supply per head, for all purposes, 19·73 gallons. Maximum day's supply, in June, 8,500 [? 85,000].

Wivenhoe.

Ordnance Map 224, new ser. (Essex 28, SW.). Geologic Map 48, SW.

1. The Hall. 1897.
Made and communicated by Messrs. Le Grand and Sutcliff.
80 ft. above Ordnance Datum.
Water-level 78 ft. down. Yield 1,000 gallons an hour, or more.
A 4-in. boring.

		Thickness. Ft.	Depth. Ft.
Soil	...		
[Glacial Drift.]	Loam and gravel ...	8	10
	Sandy gravelly clay ...	4	14
[London Clay, 115 ft. ?]	Blue clay and septaria ...	66	80
	Brown sandy clay ...	20	100
	Sand and clay ...	29	129
[Reading Beds, 50 ft.]	Green sand ...	1	130
	Green and brown sandy clay ...	13	143
	Hard clay ...	2	145
	Hard sandy clay ...	32	177
	Green sand ...	2	179
[Upper] Chalk and flints	...	36	215

The division between the London Clay and the Reading Beds is doubtful and may perhaps be higher up.

In 1900 this well was used temporarily for the supply of Wivenhoe.

For an analysis of the water, see p. 464.

2. For the Urban District Council. A quarter of a mile north-west of the Rectory. Trial-boring. 1900.
Communicated by Messrs. Sands and Walker [partly by specimens].
104½ ft. above Ordnance Datum.

At the depth of 270 ft. the water-level was from 96 to 98 ft. down, but it was easily lowered about 60 ft., as also at lower depths. Yield at the last only 1,100 gallons an hour. Water not satisfactory (brackish). Abandoned.

		Thickness. Ft.	Depth. Ft.
Soil	...	1	1
[Glacial Drift.]	[Sand, rather coarse, many small stones]...	5	6
	[Sand, sharp and coarse] ...	5	11
	[Light-brown sandy clay, dried hard]...	1	12
	Gravel [and sand], with much water ...	10	23 [should be 22]
[London Clay, 97½ ft.]	[Ferruginous brown and grey clay] [Grey sandy clay] [Septaria] [Brownish-grey sandy clay] ...	81½	104½
	Buff sandy clay [fine sand] ...	13	117½
	Flint-pebbles ...	3	120½
[Reading Beds, 76½ ft.]	[Brown and grey clay] ...	2	122½
	Hard brown clay ...	4	126½
	Light-blue clay ...	8	134½
	Brown clay ...	4	138½
	Light-blue clay ...	4	142½
	Green and brown sandy clay [dried firm] ...	21	163½
	Grey sand [coarse] and bands of clay ...	6	169½
	Hard blue [brownish] sandy clay ...	20	189½
	Hard brown clay ...	4	193½
	Green sandy clay [greenish grey] ...	3	196½
	[Green-coated flints and flint] ...	½?	197
[Upper Chalk.]	Soft chalk (for some feet). Hard chalk. Bed of large irregular flints at 465 to 470 ...	303	500

Wivenhoe, cont.

An account, communicated by Messrs. LE GRAND and SUTCLIFF, who made the boring, differs in details, as follows:—

		Thickness. Ft.	Depth. Ft.
[Glacial Drift.]	Gravel and sand	6	6
	Sand, gravel and thin bands of clay ...	10	16
	Sand and gravel	7	23
[London Clay, 101 ft.]	Blue clay, with clay stones (18 ins. at 98 ft. and 12 ins. at 101)	85	108
	Sandy clay	13	121
	Sand and pebbles	3	124
[Reading Beds, 73 ft.]	Brown and blue clay	18	142
	Blue clay	1	143
	Green sand	2	145
	Green sandy clay	15	160
	Grey sand and bands of clay	6	166
	Sandy clay	26	192
	Brown clay	2	194
	Green sandy clay	3	197
[Upper] Chalk and flints		303	500

Dr. THRESH, in his Report on the Water Supply of Essex, p. 29, 1901, gives a slightly different account. For analysis of the water, see p. 464.

3. Second boring for the District Council. On the northern side of Queen's Road, north-east of the school. 1901.

Boring of 6 in. diameter. Communicated by H. H. SANDS.

$18\frac{1}{2}$ ft. above Ordnance Datum.

Water stands 13 ft. down. A good supply got at the bottom (130 ft.).

Yield. 1,814,400 gallons pumped in 14 days, which only lowered the water-level by 3 ft. On ceasing pumping the original level was immediately regained (1901).

Pumping at 9,000 gallons an hour reduced the level by 5 ft. (1901).

		Thickness. Ft.	Depth. Ft.
Clayey soil		7	7
Gravel and sand		3	10
[London Clay, 35 ft.]	Black loam	4	14
	Black blue clay	14	28
	Light silver sand	3	31
	Blue clay	14	45
[Reading Beds, 65 ft.]	Mottled clay	7	52
	Sand, with a small quantity of water	3	55
	Green sandy clay	16	71
	Dark clay	3	74
	Sand, with a little water	2	76
	Black clay	26	102
	Black loam	8	110
[Upper] Chalk, with 3 layers of flints		20	130

A less detailed version is given in Dr. THRESH'S Report on the Water Supply of the County of Essex, p. 132 (1901).

For an analysis of the water, see p. 464.

Wix or Wicks.

Ordnance Map 224, new ser. (Essex 20, SE., 29, NW., NE.).

Geologic Map 48, SW.

According to Dr. THRESH'S Report of 1901, p. 128, partly supplied by the Tendring Hundred Water Co., but many houses used shallow wells (? in loam or gravel), and in some cases the supply was not what it should be.

Woodham Ferrers (Ferris of old map).

Ordnance Maps 241, 258, new ser. (Essex 61, NE., SE.). Geologic Map 1, NE.

1. Railway Station, more than a mile south-south-east of the church. 1888.
Communicated by W. T. Foxlee, Resident Engineer, Essex Lines.
25 ft. above Ordnance Datum.
Shaft 15 ft., the rest bored. Water rose to within $7\frac{1}{2}$ ft. of the surface.
Quality good.

			Thickness. Ft.	Depth. Ft.
[London Clay.]	Brown clay		15	15
	Blue clay		294	309
	[Basement-bed.]	Sand	$\frac{1}{3}$	$309\frac{1}{3}$
		Black [flint] pebbles and clay	3	$312\frac{1}{3}$
[Reading Beds ?]	White sand and water		9	$321\frac{1}{3}$

An account from Messrs. Le Grand and Sutcliff varies in the details of the London Clay, as follows:—

Brown clay	55	313 ft.
Blue clay and clay-stones	$254\frac{2}{3}$	
Black pebbles and clay [basement-bed] ...	$3\frac{1}{3}$	

2. Hyots Farm. On the Marshes.
Information from the tenant.
About 15 ft. above Ordnance Datum.
Boring said to end in Thanet Sand.
For an analysis of the water, see p. 465.

Woodham Walter.

Ordnance Map 241, new ser. (Essex 53, NE.). Geologic Map 1, NE.
Walter House. Near Hoe Mill, 10 yds. from River Chelmer.
Information from Capt. the Hon. R. Moreton.
About 25 ft. above Ordnance Datum.
Said to be 112 ft. deep, ending in Thanet Sands.
Yield sufficient for the premises Water faintly opalescent. For analysis, see p. 465.

Wormingford.

Ordnance Map 223, new ser. (Essex 18, NW. and SW.). Geologic Map 48, NW.
Information from Dr. J. W. Cook.

The supply used to come from shallow wells.

In 1903 a boring was made at Mr. Tufnell's cottages to the depth of 186 ft. Chalk being reached at 145, and the water-level being 70 ft. down.

In 1911 a well, 35 ft. deep, was sunk at Church House, and a new well was made at Stone cottages.

According to Dr. Thresh's Report of 1905, p. 72, the rectory got a supply from a spring, piped from a hill near by.

Wrabness.

Ordnance Map 224, new ser. (Essex 20, SE.). Geologic Maps 48, NW. and NE.
Was formerly supplied wholly from shallow wells (presumably in gravel). Is now in the area of the Tendring Hundred Water Co.

Writtle.

Ordnance Map 240, new ser. (Essex 52). Geologic Map 1, NE.

1. At the roadside half way up Oxney Green.
A private well, sunk by a gentleman for the use of neighbouring parishioners.
Measured in 1899. Sunk 100 ft., bored not quite 200. Sand in the tube.
For an analysis of the water, see p. 465

Writtle, cont.

2. Public supply. Chelmsford Rural District Council. Boring. At the top of Oxney Green. 1902.

Communicated by J. DEWHIRST.

188 ft. above Ordnance Datum.

Water-level 99 ft. down at first (1902).

Yield, 14 days' trial pumping at 40,000 gallons a day, 1902. After removal of pump ($1\frac{3}{4}$ hours) the water-level was 135 ft. down.

	Thickness Ft.	Depth. Ft.
[Glacial Drift] Gravel ...	50	50
London Clay ...	$249\frac{1}{2}$	$299\frac{1}{2}$
[Lower London Tertiaries] Sands ...	$150\frac{1}{2}$	450
[Upper] Chalk	125	575

When 450 ft. deep the well yielded a fair amount of water; but this was sandy. On boring being continued into the Chalk nearly all the water disappeared. The Chalk bore was plugged, and the yield increased to the amount given above. For analyses of the water, see p. 465.

The accounts of the following old shallow wells (3–11) are from information collected by W. H. DALTON.

3. Bumsteads. From Mr. ROLFE, the sinker.

Sandy [rainwash]	8	41 ft.
Brown [weathered London] clay ...	8	
Blue [London] clay	25	

Bivalve-shells found between the two clays.

4. The Causeway (road to Highwood, a mile westward of Writtle).

[Glacial Drift.]	[Boulder Clay.] White marl	5	35 ft.
	[Boulder Clay.] Blue marl...	12	
	Dark sand and gravel	10	
London Clay		8	

5. Chequers Lane, south of Oxney Green.

[Drift.]	Sand and gravel ...	17	$28\frac{1}{2}$ ft.
	Hard gravel ...	4	
	Brown clay	$1\frac{1}{2}$	
	Sand and gravel ...	6	

6. At the bottom of Chequers Lane. Gravel 14 and sand 6 ft.

Mr. DALTON notes that the brickearth hereabouts is decalcified Boulder Clay, an unaltered part of which was shown in a new section in 1891.

7. Cooks Mill Green.

[Glacial Drift.]	[Boulder Clay.] White marl	12	40 ft.
	[Boulder Clay.] Blue marl	22	
	Sand and gravel	6	

8. Hylands Park (in three parishes). From Mr. PURKIS.

Gravel and sand, to London Clay, 30 ft.

9. Keepers. [Boulder Clay.] White marl 3 and Blue marl 19 ft.

10. Little Moor Hall.

[Glacial Drift.]	White marl	17 ft.	Nearly 39 ft.
	Sand and gravel	4 in.	
	Blue marl	21 ft.	
	Black sand, to London Clay...	6 in.	

11. Love's Green, near Highwood Church.

[Glacial Drift.]	White marl	7 to 8	? 26 ft.
	Dark stony loam	7 to 8	
	Black sand, to blue [London] clay	12 to 14	

Writtle, cont.

In a Report in 1891, Dr. THRESH says, "The gravel varies in thickness from about 60 ft. on the highest part of Oxney Green to about 8 to 10 feet in the lowest part of the village near the river. The water level varies much." In Chequers Lane it is $4\frac{1}{2}$ to 9 ft. down: at Baker's cottages about 200 yds. off and at about the same height, 45 ft.: at cottages about midway between these two, 16 ft.; lower down the Green, 54 ft.: and from this gradually nearer the surface, being 11 ft. down at the public pump and about 9 ft. in wells at the lowest part of the village. "The level of the ground water falls in the direction of the two streams . . . at the outskirt of the village. At Oxney Green the wells yield a very limited supply in summer. . . . In the village the supply is abundant, but . . . the quality in nearly every instance leaves much to be desired."

The chief village-supply was a spring, piped to the brewery and thence to the roadside; but there still remained a population of 400 to 500, in the outlying parts, dependent upon shallow wells. Away from population the gravel yields very good water. Dr. THRESH's Report of 1901, p. 105.

The village is now supplied with water from the works of the Chelmsford Rural District Council (see p. 320).

For comments on the water of 48 shallow wells, see pp. 59, 60.

Yeldham, see **Great Yeldham.**

Doubtful Site.

Mr. Deloitte's House. Near Grays.

An old well. Locality not determined. Seems to be in the Tertiary tract northward of Grays, and, if so, is of interest, as wells have not been described from that part.

Communicated by Prof. D. T. ANSTED.

Sunk 50 ft., bored 280 ft., with 4-in. bore-hole. Tertiary cover 280 ft.

Water-level 30 ft. down.

For an analysis of the water, see p. 466.

North Woolwich.

Ordnance Maps 257, 271 (Essex 81, NE., 82, NW.). Geologic Maps 1, SW., and London District, Sheets 2, 4.

The following wells are in that part of Kent which stretches across the Thames into the tract of the Essex Marshes. They were purposely left out of the Geological Survey Memoir on the Water Supply of Kent (1908) as not being physically in that county:—

1. Silvertown. Messrs. Brunner, Mond and Co., Crescent Wharf. Two wells.

Made and communicated by Messrs. ISLER and Co.

(*a*) Water-level 10 ft. down. Supply 6,000 gallons an hour.

		Thickness. Ft.	Depth. Ft.
Made ground and clay [Alluvium]		4	4
[River Drift, 36 ft.]	Ballast [gravel]	15	19
	Ballast and sand ...	3	22
	Ballast	18	40

(*b*) Water-level 7 ft. down. Supply 6,000 gallons an hour.

Made ground, peat and clay [Alluvium]	15	35 ft.
[River Gravel.] Ballast	20	

North Woolwich, cont.

2. Victoria Ale Stores. Messrs. Fosters.
Boring made and communicated by Messrs. Baker.

		Thickness. Ft.	Depth. Ft.
Made ground	... ...	2	2
[Alluvium.]	Yellow clay ...	7	9
	Peat	9	18
[River Drift.]	Ballast	$18\frac{1}{2}$	$36\frac{1}{2}$
	Flints	$\frac{1}{4}$	$36\frac{3}{4}$
[Upper] Chalk	... ...	$269\frac{1}{4}$	306

For details of the following North Woolwich or Silvertown wells, see the Memoir on London Wells, by G. Barrow, 1912, pp. 102, 103.

3. South of Albert Docks. Wholesale Co-operative Society. 1902.
20 ft. above Ordnance Datum.
Water-level at O.D. Supply 13,000 gallons an hour.

Made ground (6), Alluvium (24), and Gravel (30) ...	60	450 ft.
Thanet Sand	35	
Upper (and ? Middle) Chalk	355	

4. North Woolwich Road, near the river. Messrs. Venesta. 1910.
20 ft. above Ordnance Datum.
Water-level 3 ft. below O.D. Supply 3,000 gallons an hour.

Alluvium and River Drift	39	400 ft.
Woolwich Beds and Thanet Sand ...	82	
Upper Chalk	279	

5. Factory Road. District Chemical Works. 1897.
15 ft. above Ordnance Datum.

Brackish water, in the Chalk. This was successfully shut out and fresh water met with at 170 ft.

Supply 3,280 gallons an hour. Abandoned in 1901 as the water was too chalky.

Alluvium and gravel ...	40	200 ft.
Upper Chalk	160	

6. India Rubber, etc., Telegraph Works Co. 1879.
8 ft. above Ordnance Datum.

Yield 6,800 gallons an hour. In 1895 Thames water got in. Not used.

Made earth, Alluvium and Gravel ...	51	500 ft.
Thanet Sand	19	
Upper (and ? Middle) Chalk	480	

TRIAL BORINGS NOT FOR WATER.

The greater number of the following accounts of trial-borings have been published (and almost wholly in 'The Geology of London,' vol. ii); but many are now printed for the first time. With one exception there is nothing specially notable about these borings; though many of them are useful as giving the thickness of the Alluvium and of various divisions of the Drift, in the former case the many borings at the set of docks along the Thames being noteworthy.

The one exception, however, is of great importance, for the Weeley boring (p. 343) is the deepest exploration made in Essex; starting in Eocene Tertiaries; proving the thickness of the Chalk and of the Gault; showing that the Lower Cretaceous beds and the whole of the great Jurassic, Triassic, Carboniferous, and Devonian systems are there absent; and reaching rocks of Silurian or older age.

It is therefore a corroboration of the newer reading of the Harwich boring (p. 184), especially when taken with the Stutton boring, just within the border of Suffolk, which has been described in the Memoir on the Water Supply of that county (pp. 4, 140-142). These four deep borings tend to show that there is small chance of finding Coal Measures in the north-eastern corner of Essex and its Suffolk border-land. Details of the Weeley boring are now given for the first time.

METROPOLITAN BOARD OF WORKS TRIAL-BORINGS, FROM CONTRACT-DRAWINGS.

Low Level Sewer, North Side. Main Line.

1. A little south-west of Abbey Mill Toll Bar (on south of the Engine House). 6·5 ft. above Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
[Alluvium ?]	Black soil	½	½
	Yellow clay (water at bottom)	1½	2
[Valley Drift, 14 ft.]	Clay and gravel	2	4
	Sand and gravel	12	16
Grey clay		2	18
Soft sand		14	32
Loamy sand		11	43
Stiff clay		7½	50½

2. A little north-east of Three Mills Bridge. 7 ft. above Ordnance Datum. Water-level about 5 ft. down.

[Alluvium, 6½ ft.]	Black soil	1	1
	Loamy clay	1½	2½
	Peat	4	6½
Sharp sand and ballast [gravel]		19	25½
Blue [? London] Clay		14½	40
[Woolwich and Reading Beds.]	Soft, white sand	½	40½
	Pebbles and sand	1½	42
	Black sand	3	45
	Shells and clay	½	45½
	Coloured [mottled] clay	4	49½
	Sand and clay	½	50

Outfall Sewer, North Side.

1 to 26. Across the marsh of the Lea, from a little south of Old Ford Lock to Abbey Mill, may be massed as follows:—

Surface-earth or made ground; from 9 in. to 10 ft.

Alluvium. Chiefly clay (sometimes described as soft or silty, sometimes as mud or loam; sometimes mixed with gravel); often with peat, from 10 in. to 8 ft.; sometimes with a little gravel, containing decayed wood; sometimes with soft or silty sand at the base, $1\frac{1}{2}$ to 5 ft.; total thickness $2\frac{1}{4}$ to $14\frac{1}{4}$ ft.

Total depth to gravel from $3\frac{1}{4}$ to 20 ft. In one case (No. 26, between Abbey Creek and the channel immediately east) gravel not touched at 22 ft.

Gravel (with shells in No. 1), touched, or pierced to 10 ft.

27. On the eastern side of the stream, Abbey Wharf.

		Thickness. Ft.	Depth. Ft.
Hard made ground	...	$4\frac{1}{2}$	$4\frac{1}{2}$
[River Drift.]	Dark, soft soil ...	$1\frac{1}{2}$	6
	Light-coloured, soft clay ...	$4\frac{1}{2}$	$10\frac{1}{2}$
	Hard, red gravel ...	2	$12\frac{1}{2}$
	Green, sandy gravel, with much water	3	$15\frac{1}{2}$
Hard [London] Clay	...	$17\frac{1}{2}$	33

28 to 35. From just west of the North Woolwich Railway, north of Marsh Lane, to about a third of a mile west-south-west of Plaistow Broadway, may be grouped thus:—

Surface-earth, or made ground; 1 to 3 ft.

[River Drift.] { Clay or loam; 1 to 5 ft.
Gravel; $2\frac{1}{2}$ to 9 ft. (then pierced).

London Clay (No. 31 only, near Tilbury Railway); 3 ft.

36 to 51. From about $\frac{1}{4}$ mile west of Balaam Street, Plaistow, to a little west of East Ham Hall Manor Way, near the edge of the marsh, give the following general section:—

Surface-earth, or made ground; to 3 ft.

[River Drift.] { Loam; 0 to 4 ft.
Gravel, often with sand, sometimes with loamy clay; $3\frac{1}{4}$ to 18 ft. (not then pierced).

[London] clay, at 2 places (Nos. 41 and 45) 13 and 11 ft. down; bored into 18 and 11 ft.

52 to 80. Across the marsh (East Ham Level), from close to the edge, just east of the Manor Way, to west of Barking Creek, show the following beds:—

Surface-earth; 0 to $1\frac{3}{4}$ ft.

Alluvium. Clay; often described as sandy, silty or soft, or as mud; mostly with peat, from a foot to 11 ft. thick, at one place 3 beds; sometimes soft or muddy sand at the base. Total thickness, at No. 52 only $1\frac{1}{2}$ ft., elsewhere $8\frac{1}{2}$ to 22, thickest near the river.

Gravel; 3 to 13 ft. (then, in No. 71, with sand at the base, and pierced to London Clay).

Northern Outfall Reservoir, 1863.

1 to 6 may be massed as follows:—

Surface-earth, a foot.

Alluvium. Peat, from 5 to 17 ft. thick, and clay; total thickness, $9\frac{1}{2}$ to $26\frac{1}{4}$ ft.

Sand and gravel; $1\frac{1}{2}$ to $18\frac{1}{2}$ ft.

The upper part of the sand being mostly described as dirty or silty it is possible that some of it may belong to the Alluvium, rather than to the River Drift.

METROPOLITAN BOARD OF WORKS MS. BORINGS.

North of the Thames.

A. 1,160 ft. west of mouth of Barking Creek and 125 ft. in the Thames. 2 ft. above Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
[Alluvium, 17½ ft.]	Blue mud	10	10
	Brown peat	2	12
	Light mud	2	14
	Mixed brown and light loam ...	2	16
	Brown peat	1	17
[Valley Drift ? 27 ft.]	Gravel, with water	22½	39½
	Quick sand	3	42½
	Loam, with gravel	1½	44
[Lower London Tertiaries ?]	Loam and sand	8½	52½
	Loam and fine sand	12½	65
	Green sand	10½	75½

Messrs. DOCWRA make the fourth bed 2½, and the total therefore 76.

B. to H. Across the marsh (East Ham Level, etc.) from the embankment of the Thames 1,160 ft. west of Barking Creek, at first near the borings along the course of the Northern Outfall Sewer, then gradually getting northward of that line, toward the Roding, to near the edge of the marsh at the footpath about a third of a mile south of the Barking Road.

Soil or made ground, 2 to 4 ft.

Alluvium, consisting of clay, mud or loam, with peat, 1 to 10 ft. thick; total thickness from 6⅔ to 28 ft. (thickest near the Thames).

Gravel and sand, from 6⅔ to 25 ft.

[London] clay touched (Jenkins Lane, half a mile south-east of High Bridge) at 35⅓ ft., and (at the last) at 17 ft.

I. On Footpath, 2½ furlongs south of East Ham Tollgate, on the Barking Road.
15 ft. 1 in. above Ordnance Datum.

	Thickness. Ft.	In.	Depth. Ft.	In.
Surface soil	1	6	1	6
Brown clay [brick-earth ?] ...	10	0	11	6
Blue [London] Clay	35	2	46	8

J. 1¼ furlongs south-west of East Ham Tollgate, on the Barking Road.
27½ ft. above Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
Brown soil		3	3
[Valley Drift, 31½ ft.]	Yellow sand	5½	8½
	Yellow gravel, with water	26	34½
Blue [London] Clay		4½	39

K. 3¾ furlongs east of Plaistow Church and 880 ft. north-west of the junction of Green Street with Barking Road.
26·1 ft. above Ordnance Datum.

		Thickness. Ft.	In.	Depth. Ft.	In.
Brown soil		2	7	2	7
[Valley Drift, 8¾ ft.]	Brown loam, with pebbles	2	6	5	1
	Yellow loam, with water ...	4	0	9	1
	Brown gravel	2	4	11	5
Blue [London] clay		27	2	38	7

Messrs. DOCWRA make the top bed only 2 ft.

L. 2¼ furlongs south-east by east from Plaistow Church.
12 ft. above Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
Brown soil		1½	1½
[Valley Drift, 10½ ft.]	Yellow loam ...	4	5½
	Quick sand ...	4	9½
	Brown gravel ...	2	11½
Blue [London] Clay		26	37½

Messrs. Docwra make the second bed 4½, and the total therefore 38.

M. In Marsh Lane, western side of North Woolwich Railway and 3⅓ furlongs south of West Ham Abbey Railway Bridge.
4½ ft. above Ordnance Datum.

	Thickness. Ft.	Depth. Ft.
Brown soil	2	2
Blue mud [Alluvium] ...	6½	8½
Gravel, with water	6½	15
Blue [London] Clay	19	34

N. About 180 ft. east of Bow Creek and 600 ft. south of the junction of Bow Creek and Channel Sea River.
6 ft. 4 in. above Ordnance Datum.

		Thickness. Ft.	In.	Depth. Ft.	In.
Brown soil		1	0	1	0
[Alluvium, 6¼ ft.]	Brown mud	2	9	3	9
	Brown peat	0	3	4	0
	Blue mud	2	10	6	10
	Brown peat	0	6	7	4
Fine, yellow gravel		9	2	16	6
Blue [London ?] clay		30	6	47	0
[Woolwich Beds ?]	Brown stone (not a bed)	1	2	48	2
	Light-brown sand ...	4	1	52	3
	Light loam	2	0	54	3
	Blue sand	5	3	59	6

O. Between Bow Creek and River Lea.
14 ft. 4 in. above Ordnance Datum.

	Thickness. Ft.	Depth. Ft.
Made ground	1½	1½
Blue mud [Alluvium] ...	16	17½
Yellow gravel	7½	25
Blue [London] Clay	16	41

12. Blackwall, between the River Lea (Bow Creek) and Victoria Docks, near the Thames.
6·68 ft. above Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Yellow clay	2	2
	Dark, stiff clay	12	14
[Valley Drift, 8¾ ft.]	Rough, shingly gravel	5	19
	Soft mud and running sand, with water	1¼	20¼
	Rough shingly gravel, with water [which rises with the tide in the Thames, according to Messrs. Docwra]	2½	22¾
London Clay		37½	60¼

13. Barking Creek (a little east of, and near the Thames ?).
6·6 ft. above Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Yellow clay	$2\frac{1}{2}$	$2\frac{1}{2}$
	Dark clay	4	$6\frac{1}{2}$
	Peat	$13\frac{1}{2}$	20
[Valley Drift.]	Sharp, rough grit sand, with water ...	3	23
	Rough, hard gravel, with water ...	13	36
[Thanet Sand ?]	Fine sand and mud, with water ...	10	46
[Upper] Chalk	... ...	13	59

BORINGS FOR DOCKS.

Dagenham Dock.

Ordnance Map 257, new ser. (Essex 74, SW. and SE.).
Communicated by W. H. Penning.

1. North of the Lake.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Yellow or marsh-clay	3	3
	Peat	8	11
	Blue clay	8	19
Gravel and sand	... ...	3	22

2. Near the south of the Lake, on the eastern side.

[Alluvium.]	Yellow clay ...	2	2
	Blue clay ...	5	7
	Peat	8	15
	Blue clay ...	2	17
[Valley Drift.]	Gravel ...	2	19
	Sand	5	24

Royal Albert Docks (East Ham Level).

Ordnance Map 257, new ser. (Essex 81, NE.).

41 borings, from a tracing communicated by the engineer, Mr. Andros, show the following beds:—

Alluvium; varying in thickness from $8\frac{1}{2}$ to 39 ft. This consists of clayey beds (from 5 to 19 ft. thick), of peat, sometimes two beds (from a foot to 24 ft. thick), and occasionally of sand or silt, from a foot upward.

Gravel; from 6 to 24 ft. thick, where pierced through.

Woolwich Beds, sometimes found; consisting of clays (partly with shells), sands, stone, marl and green sand with pebbles; up to $28\frac{1}{2}$ ft. thick.

Thanet Sand, touched in two cases.

The following are selected, as the most important borings:—

3. North-east of Woolwich Railway, about 100 yds. north of the eastern end of the Victoria Dock.
7 ft. 7 in. below T.H.W.M.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Brown clay	2	2
	Coloured clay	3	5
	Peat	$3\frac{1}{2}$	$8\frac{1}{2}$
[River] Gravel	... ...	$17\frac{1}{2}$	26
[Woolwich Beds.]	Rock stone	$\frac{1}{2}$ or $1\frac{1}{2}$	$27\frac{1}{2}$?
	Hard stone	3 or 2	$29\frac{1}{2}$
	Blue clay, with shells ...	$1\frac{1}{2}$	31
	Solid, blue clay ...	4?	35
	Clay, with shells ...	9	44
	Coloured clay	4	48
	Marl rock	1	49
	Rock and sand ...	1	50

Royal Albert Docks, cont.

4. At the eastern end of the entrance to the Victoria Dock.
8 ft. below T.H.W.M.

		Thickness. Ft.	In.	Depth. Ft.	In.
[Alluvium, 22½ ft.]	Brown clay	5	0	5	0
	River mud	5	6	10	6
	Peat	12	0	22	6
[River] Gravel	... ...	8	6	31	0
[Woolwich Beds.]	Blue clay, with shells ...	7	0	38	0
	Brown sand	1	8	39	8
	White marl	5	10	45	6
	Light-brown sand ...	2	0	47	6
	Green sand	2	6	50	0

5. East of the North Woolwich Railway, near the south-western corner of the Dock.
7¾ ft. below T.H.W.M.

		Thickness. Ft.	In.	Depth. Ft.	In.
[Alluvium, 25½ ft.]	Brown clay	3	0	3	0
	Blue dirt	6	9	9	9
	Peat	15	8	25	5
[River] Gravel	... ...	6	1	31	6
[Woolwich Beds.]	Stone	2	9	34	3
	Clay, with shells ...	2	0	36	3
	Mixed sand	3	0	39	3
	Brown sand	2	8	41	11
	White sand	3	1	45	0
	Mixed sand	5	0	50	0
	Green sand and pebbles	6	0	56	0
	Black sand and pebbles	4	0	60	0
Light-coloured Thanet Sand	... ...	1	6	61	6

6. East of the North Woolwich Railway, and about 100 yds. south of the south-western corner of the Dock.
8 ft. 2 in. above T.H.W.M.

		Thickness. Ft.	In.	Depth. Ft.	In.
[Alluvium.]	Brown clay	2	0	2	0
	Blue clay	3	6	5	6
	Peat	12	0	17	6
[River Drift.]	Gravel	7	6	25	0
	Stone	1	1	26	1
	Gravel	5	5	31	6
[Woolwich Beds.]	Marl rock	2	6	34	0
	Light-coloured sand ...	? 3	0	37	0
	Brown sand	? 3	6	40	6
	Mixture of sands ...	? 4	0	44	6
	Green sand and pebbles	12	0	56	6
Grey [Thanet] sand	... ...	3	6	60	0

15. About 50 yds. north of the southern wall of the Dock, towards the middle
7½ ft. below T.H.W.M.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Mould	1	1
	Clay	4	5
	Silt	5½	10½
	Peat	12½	23
	Silt	3	26
	Peat	3	29
[River Gravel]	... ...	5	34
[Woolwich Beds.]	Green sand ...	4¾	38¾
	Sandstone	2¼	41

Royal Albert Docks, cont.

New entrance. 1884?

Communicated by Col. Martindale, R.E., C.B.

Seven borings along a line prolonged from the side of the outer basin, beginning at about 440 ft. from the corner, and thence for about 580 ft., nearly to the river-bank.

[Alluvium.] {
a Clay, from over 4 to 9 ft.
b Peat, from 9 to 14 ft.
c Bog [marsh-clay], from 4 to 11 ft.
d Silty sand, only in the three nearest the river, 2 to 4 ft.

Depth to gravel, 22 to 30 ft., deepest near the river.

Five borings, along the southern side of the proposed extension of the basin, parallel to the above, show the same beds, *a* 6 ft. thick; *b* from 6 to 10; *c* over 5 to over 6; and *d* from 2 to 2½; the depth to the gravel varying from 23 to 33 ft.

Eight borings along the middle of the new entrance, and nearly parallel to the other two sets, showed the following:—

Filling [earth thrown out of the older dock], on the west, 11 to 13 ft.

[Alluvium.] {
Clay, from 5 to 7½ ft.
Peat, from 6½ to 9 ft.
Bog [marsh-clay], from 5 to 12½ ft.
Blue clay, from 0 to 3½ ft.

Depth to gravel, 24 to 34 ft.

Having seen the works in progress, in 1885, I have inserted the term marsh-clay after 'bog,' as the latter might be taken to mean a sort of peat, whereas the bed is really of the same kind as the clay above the peat, though probably more moist.—W.W.

New entrance, etc., works. Main Sump, between entrance and basin.

From information on the spot, February, 1885.

[Alluvium.]	Silt	4
[River Gravel.]	Flints	1
	Sand and gravel ...	17

Chalk, at 47 ft. below Trinity High Water Mark (? 6 ft. below base of work.

Tilbury Docks.

(In the parishes of Chadwell St. Mary and Little Thurrock.)

Ordnance Map 271, new ser. (Essex 88, NE., 89, NW.).

A great number of borings were made, and accounts of them have been supplied by the East and West India Dock Company. The general order of the beds has been described with some details in the Memoir on the Geology of London, etc., vol. i, and two general sections have been given. It will be enough therefore to give here a selection from the deeper of the original borings, especially those which have been carried through to the Chalk.

3. A little north-east of the north-eastern corner of the eastern graving-dock and about 35 ft. westward of the point where the sections figured (Geology of London, vol. i, p. 468) cross.

6 ft. above Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
Soil [? discoloured marsh-clay]		5¼	5¼
[Alluvium.]	Blue clay	2	7¼
	Peat	2	9¼
	Blue clay	12½	21¾
	Peat	6	27¾
	Blue clay and wood ...	12	39¾
	Peat	2	41¾
	Blue clay and reeds ...	7½	49¼
	Dead sand	6	55¼
[? River Drift]	Flints	1	56¼
Chalk		3	59¼

Tilbury Docks, *cont.*

29. Near the north-eastern corner of the Eastern Branch Dock.

About 5 ft. above Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Brown clay	$4\frac{3}{4}$	$4\frac{3}{4}$
	Blue clay	$10\frac{1}{2}$	$15\frac{1}{4}$
	Peat	$6\frac{1}{4}$	$21\frac{1}{2}$
	Blue clay	5	$26\frac{1}{2}$
	Peat	$1\frac{1}{2}$	28
	Sand	3	31
[River Drift, $27\frac{1}{4}$ ft.]	Ballast	1	32
	Loamy sand	2	34
	Ballast and sand ...	7	41
	Sand	$4\frac{1}{4}$	$45\frac{1}{4}$
	Ballast and sand ...	7	$52\frac{1}{4}$
	Rough ballast	6	$58\frac{1}{4}$
Chalk ...	... ...	2	$60\frac{1}{4}$

30. At the north-western corner of the Western Branch Dock.

About 5 ft. above Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Brown clay	$2\frac{1}{2}$	$2\frac{1}{2}$
	Dark brown clay ...	4	$6\frac{1}{2}$
	Peat	$1\frac{1}{2}$	8
	Clay and reeds	7	15
	Peat	5	20
	Blue clay	$7\frac{1}{4}$	$27\frac{1}{4}$
	Peat	$1\frac{1}{4}$	$28\frac{1}{2}$
	Sand	2	$30\frac{1}{2}$
[River Drift, $25\frac{1}{2}$ ft.]	Rough ballast and sand	14	$44\frac{1}{2}$
	Fine ballast and sand ...	6	$50\frac{1}{2}$
	Rough ballast	$5\frac{1}{2}$	56
[Upper Chalk.]	Chalk	$1\frac{3}{4}$	$57\frac{3}{4}$
	Flints	$1\frac{1}{4}$	59
	Chalk	1	60

31. On the river-bank, north of the outer end of the Western Jetty.

11 ft. above Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
Mud, stones, etc. [? partly river-wall]	...	9	9
[Alluvium, 43 ft.]	Mud and peat	2	11
	Blue clay	9	20
	Peat	$2\frac{1}{2}$	$22\frac{1}{2}$
	Blue clay	$3\frac{1}{2}$	26
	Peat	$5\frac{1}{2}$	$31\frac{1}{2}$
	Stiff, blue clay	$4\frac{1}{2}$	36
	Peat	$4\frac{1}{2}$	$40\frac{1}{2}$
	Clay and peat	1	$41\frac{1}{2}$
	Peat and wood ...	$2\frac{3}{4}$	$44\frac{1}{4}$
	Sand	$7\frac{3}{4}$	52
[River Gravel] Ballast	... ...	16	68
Chalk ...	... ...	2	70

Tilbury Docks, cont.

32. On the river-bank, north-eastward of the outer end of the Western Jetty 10 ft. above Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
Mud, stones, etc. [? in part river-wall] ...		4¼	4¼
[Alluvium, 49ft.]	Blue clay	13	17¼
	Peat	2	19¼
	Blue clay	6	25¼
	Clay and peat	1	26¼
	Peat	8	34¼
	Clay and peat	3¾	38
	Peat	2	40
	Blue clay	8	48
	Loamy sand	3½	51½
	Sand	1¾	53¼
[River Drift, 14½ ft.]	Rough ballast	9	62¼
	Sand and ballast ...	4	66¼
	Rough ballast	1½	67¾
Chalk		3	70¾

33. On the shore, westward of the Eastern Jetty. 11 ft. below Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Mud and peat	1½	1½
	Mud	2	3½
	Peat	10	13½
	Blue clay	3	16½
	Peat	3	19½
	Wood	1½	21
	Peat	2	23
	Blue clay	5½	28½
	Peat	2½	31
	Loamy sand	2¾	33¾
[River Drift.]	Rough ballast	3	36¾
	Sand and ballast ...	7	43¾
Chalk...		4	47¾

36. Near the further end of the Eastern Jetty, reached Chalk at a slightly lower level.

14A, 13A, 12A, 16A and 27A are along the line of the section fig. 100 of the 'Geology of London,' vol. i, by the southern side of the main dock, the first three being westward of No. 3 and the other two eastward. The distances between them are 175 ft., except between 12A and 16A, which are about 210 ft. apart. These, therefore, with 3, will show the changes of the beds along the section: they will be described from westward to eastward.

14A. 6 ft. below T.H.W.M.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil [? discoloured marsh-clay] ...		4	9	4	9
[Alluvium.]	Blue clay ...	2	6	7	3
	Peat	1	0	8	3
	Blue clay ...	14	9	23	0
	Clay and peat ...	2	6	25	6
	Peat	4	0	29	6
	Blue clay ...	9	0	38	6
	Wood and clay ...	1	2	39	8
	Peat	1	4	41	0
	Blue clay ...	12	3	53	3
	Sand and peat ...	0	10	54	1
Ballast [River Gravel]		14	6	68	7
Chalk		4	0	72	7

Tilbury Docks, cont.

13A. 6 ft. 8 in. below T.H.W.M.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil [? discoloured marsh-clay] ...		6	3	6	3
[Alluvium.]	Blue clay ...	2	8	8	11
	Peat	1	3	10	2
	Blue clay ...	11	6	21	8
	Clay and peat ...	3	5	25	1
	Peat	5	0	30	1
	Clay and peat ...	10	0	40	1
	Peat	5	9	45	10
	Blue clay ...	5	7	51	5
	Peat	0	9	52	2
	Loam and peat ...	1	5	53	7
Ballast [River Gravel]		13	0	66	7
Chalk		2	0	68	7

12A. Nearly 7 ft. 4 in. below T.H.W.M., over 60 ft. from Boring 3.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil [? discoloured marsh-clay] ...		6	0	6	0
[Alluvium.]	Blue clay ...	2	6	8	6
	Peat	1	6	10	0
	Blue clay ...	7	1	17	1
	Peat	6	9	23	10
	Blue clay ...	2	0	25	10
	Peat	1	8	27	6
	Clay and peat ...	11	4	38	10
	Peat	5	6	44	4
	Clay and peat ...	3	0	47	4
	Peat	1	0	48	4
	Clay	4	8	53	0
	Dead sand ...	1	10	54	10
Ballast [River Gravel]		9	2	64	0
Chalk		2	3	66	3

27A. $8\frac{1}{2}$ ft. below T.H.W.M.

		Thickness. Ft.	In.	Depth. Ft.	In.
Surface [? discoloured marsh-clay]		3	9	3	9
[Alluvium.]	Blue clay ...	3	9	7	6
	Peat	0	6	8	0
	Blue clay ...	15	0	23	0
	Peat	4	5	27	5
	Blue clay ...	11	3	38	8
	Peat	4	5	43	1
	Blue clay ...	9	0	52	1
	Dead sand ...	3	2	55	3
Rough ballast [River Gravel] ...		2	5	57	8
Chalk		2	0	59	8

16A. 7 ft. $1\frac{1}{2}$ in. below T.H.W.M.

		Thickness. Ft.	In.	Depth. Ft.	In.
Surface [? discoloured marsh-clay]		4	7	4	7
[Alluvium.]	Blue clay ...	17	4	21	11
	Peat	5	6	27	5
	Clay and peat ...	11	0	38	5
	Peat	2	0	40	5
	Clay and peat ...	5	4	45	9
	Peat and wood ...	0	6	46	3
	(Undescribed) ...	2	6	48	9
[River Drift, $10\frac{1}{4}$ ft.]	Sand and ballast	2	0	50	9
	(Undescribed) ...	1	0	51	9
	Ballast	7	3	59	0
Chalk		3	0	62	0

In 8, on the western wall of the main dock, a little south-east of its middle spot, Chalk was not touched after passing through about 50 ft. of Alluvium and 12 of gravel.

On the Dock Estate, on the other side of the railway from the docks, these borings, made (in 1885) and communicated by Messrs. ISLER, reached the Chalk at 63 ft., the beds above consisting of about equal parts of Alluvium and of coarse gravel.

Victoria Docks (Plaistow Level).

Ordnance Map 257, new ser. (Essex 81, NE.).
From notes and specimens communicated by G. AITCHISON.
(Nos. 1 and 2, on the northern side, Nos. 3, 4 and 5, on the southern.)

1. Near the north-eastern corner of 'Export Shed.'

		Thickness. Ft.	Depth. Ft.
[Alluvium, 11 ft.]	River mud ...	2	2
	Peat	7	9
	Silt	2	11
[River Drift, 16 ft.]	Rough gravel ...	2	13
	Gravel	12	25
	Sand [gravelly] ...	2	27

2. North Dock Bank, 140 ft. west of 'Searchers.' Through the bank (made ground) which is about 16 ft. above the marsh-level, to gravel, 26 ft.

3. At the western end of the [former] rifle-range, at the southern end of F Shed.

5. At [former] rifle-butt, 250 yds. east of F Shed.

		Thickness. Ft. (3.)	Thickness. Ft. (5.)
[Alluvium.]	Soil [alluvial clay]	1	1
	Peat	5	$1\frac{1}{2}$
	Blue mud [alluvial clay, dries brown]	$4\frac{1}{2}$	$7\frac{1}{2}$
	Peat, to gravel	$8\frac{1}{2}$	6
		19	16

4. On marsh, 125 yds. east of F Shed, midway between 3 and 5.

		Thickness. Ft.	Depth. Ft.
[Alluvium, $17\frac{1}{2}$ ft.]	Soil [? alluvial clay]	5	5
	Clay	4	9
	Blue river-mud [dried brown] ...	7	16
	Peat	$1\frac{1}{2}$	$17\frac{1}{2}$
Gravel, varying from coarse at top to sand at bottom, to [London] Clay		$17\frac{1}{2}$	35

Plaistow Marsh. (? at river-side) opposite to Woolwich Dockyard.
From the 'Sections of Borings for the proposed Tunnel Sewer,' by J. PHILLIPS, Surveyor (1849).
Surface about $7\frac{3}{4}$ ft. below T.H.W.M.

		Thickness. Ft.	In.	Depth. Ft.	In.
[Alluvium, $12\frac{3}{4}$ ft.]	Brownish loam	2	2	2	2
	Brown clay	1	10	4	0
	Peat, with masses of wood (3 beds) ...	8	9	12	9
[Valley Gravel, $23\frac{1}{4}$ ft.]	Coarse, grey sand	2	4	15	1
	Sharp, shingly gravel	20	0	35	1
	Clean, sharp sand	1	0	36	1
[Upper] Chalk with courses of flint every 4 or 5 ft. ...		64	0	100	1

BORINGS FOR RAILWAYS.

Four borings [along the line of a proposed railway]. Division 1, London to Cambridge. From a book of MS. borings in the Geological Survey Office.

No. 6. *Theydon Garnon.*—25 chains south of road at Coopersale Forest, beyond road from Park House to Epping. Ordnance Map 240.

Yellow clay	10	62 ft.
Red sand	3	
Black clay and sand ...	45	
Strong blue clay ...	4	

No. 7. *Takely.*—At a point 16 chains south of the road from Brick End to Wood Farm. Ordnance Map 222, new ser.

[Boulder Clay.]	Clay	4	ft.
	Blue clay, with small Chalk, very hard	22	

No. 8. *Debden.*—At a point 49 chains north of the road to Sibley's Farm. Ordnance Map 222, new ser.

[Boulder Clay.]	Clay	6	ft.
	Blue clay intermixed with Chalk ...	29	

No. 9. *Wimbish.*—At a point 26 chains north of the road from Elder Street to Debden. Ordnance Map 222, new ser.

[Boulder Clay.]	Clay intermixed with stones	9	ft.
	Blue clay intermixed with small stony Chalk	41	

London, Tilbury and Southend Railway.

Lea River and Bow Creek Bridge (partly in Middlesex).

Ordnance Map 256, new ser.
Made and communicated by Messrs. Docwra.

1. Outside pier, by the western side of the Lea.

	Thickness. Ft.	Depth. Ft.
Soil and stones, and black sand and stones	4	4
[Alluvium.] Soft mud	6	10
[Alluvium.] Peat	1	11
Ballast [River Gravel], rough and clean, except the bottom 6 ins.; to blue [London] Clay	9	20

2a. Between the piers.

	Thickness. Ft.	Depth. Ft.
Made ground	4	4
[Alluvium.] Blue clay	8	12
[Alluvium.] Peat	2	14
Ballast [River Gravel]	9	23
Sandy blue [London] clay	26	49
[? Basement-bed, or Oldhaven Beds.] Black sand	4	53
Sand and shells	1	54
Pebbles	1	55
Green sand	2½	57½
Black sand and shells ...	1½	59
[Reading Beds.] Black clay	½	59½
Mottled clay	½	60

2. Outside pier, on [the western ?] side of the Lea.

Soil (a foot), and then black sand and stones	4	4
[Alluvium.] Light-coloured mud	6	10
[Alluvium.] Peat	4½	14½
Ballast [River Gravel], rough and firm, except the bottom foot; to blue [London] Clay	6½	21

3. Near the other [eastern ?] bank of the Lea, south of the railway.

Made ground	3	3
Soft black mud [Alluvium]	$14\frac{1}{2}$	$17\frac{1}{2}$
Ballast [River Gravel] small [fine] loose and dirty ; to blue [London] clay	$9\frac{1}{2}$	27

4. On the same piece of land as 3, near Bow Creek, and north of the railway.

[Alluvium.]	Soil (a foot) and then loam and clay ...	4	ft.
	Dark mud and soft decayed wood ...	$13\frac{1}{2}$	

5. Close to pier, on the other [eastern] side of Bow Creek.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Soft mud	10	10
	Soft sand	3	13
[River Gravel].	Ballast ; fine and dirty for 4 ft. ; rough and clean for 3 ; fine and clean for 7 ; to blue [London] clay	14	27

6. Outside the other pier, and a little way from the Creek.
Soft mud [Alluvium] 12 ft. Tough hard ballast [Gravel] 10 ft.

Great Eastern Railway.

Maldon.

Ordnance Map 241, new ser. (Essex 54, NW.).
Viaduct over the Blackwater, 1885 ?
Communicated by W. T. FOXLEE, Resident Engineer.

Four holes and borings on the northern side of the river, beginning about 90 ft. from the edge of the stream and ending at the edge.

Depth dug (the rest bored)		17	$17\frac{1}{2}$	22	22
Soil		1	nearly 1	nearly 1	$\frac{3}{4}$
[River Gravel.]	Coarse gravel	5	$5\frac{1}{2}$	$5\frac{1}{2}$	5
	Sandy gravel	$3\frac{1}{2}$	4	5	$3\frac{1}{4}$
[London] Clay		$22\frac{1}{2}$	22	$25\frac{1}{2}$	28

Two holes and borings in the river-bed, towards the northern and southern banks.

Depth dug (the rest bored)		16	17
[River Gravel.]	Sandy gravel ...	$1\frac{1}{2}$	$1\frac{1}{4}$
	Coarse gravel ...	—	$3\frac{1}{4}$
[London] Clay		$29\frac{1}{2}$	$27\frac{1}{2}$

Four holes and borings on the southern side of the river, beginning close to it and ending about 100 ft. from it.

Depth dug (the rest bored)		24	20	20	20
[Alluvium.]	Black mud	$3\frac{3}{4}$	2	$4\frac{1}{4}$	$3\frac{1}{2}$
	Coarse gravel ...	—	1	—	—
	Clay	—	$1\frac{1}{4}$	—	—
[River Gravel.]	Sandy gravel ...	3	over $1\frac{1}{2}$	$1\frac{3}{4}$	$4\frac{1}{2}$
	Coarse gravel ...	$3\frac{1}{4}$	$4\frac{3}{4}$	5	$2\frac{3}{4}$
[London] Clay		29	24	24	$24\frac{1}{4}$

The four northern and the four southern holes are at intervals of 30 ft. from each other (from centre to centre). The northern hole in the river-bed is separated by about 30 ft. from that on the land to the north, whilst the southern hole in the river-bed is 35 ft. from that on the land to the south, the gap between the two being about 95 ft.

Ramsey.

Ordnance Map 224, new ser. (Essex 21, SW.).
Along low-water-mark of the River Stour by Ramsay Bay, or Ray Island, west of Harwich. 1875.
Communicated by Mr. J. B. CRAWFORD.

1. North-north-east of the eastern end of the island, $2\frac{3}{4}$ ft. above low water of spring tides.

Soft black mud [Alluvium]	$28\frac{1}{2}$	40 ft.
Sand and gravel [? River Drift] ...	$11\frac{1}{2}$	

2. North-north-west of the eastern end of the island, $2\frac{1}{2}$ ft. above low water of spring tides.

[Alluvium.]	Soft black mud ...	$28\frac{1}{2}$	$42\frac{1}{2}$ ft.
	Peat	1	
[? River Drift.]	Fine sand	$1\frac{1}{2}$	
	Sand and gravel ...	$11\frac{1}{2}$	

Left off in a bed of flints, with hardly any sand.

3. North-westward of the eastern end of the island, 4 ft. above low water of spring tides.

Soft black mud [Alluvium]		$25\frac{1}{2}$	$34\frac{3}{4}$ ft.
[River Drift.]	Sand	1	
	Sand and gravel ...	$8\frac{1}{4}$	

MISCELLANEOUS BORINGS.

Barking.

Ordnance Map 257, new ser.
Messrs. E. Easton and Co. Testing for brick-clay.
Made and communicated by Messrs. LE GRAND and SUTCLIFF.

		Thickness. Ft.	Depth. Ft.
Dug well (the rest bored) [? gravel]		11	11
[River Drift.]	Gravel	7	18
	Gravel and sand	5	23
Blue [London] clay		29	52

Canvey.

Four borings, for testing the ground. For Messrs. Jacobs and Barringer.
At the south-western end of the island.
Ordnance Map 258, new ser. (Essex 77, SW., or 85, NW.).
Made and communicated by Messrs. ISLER and Co.
These are of interest as showing the character of the Alluvium.

		1 Dug. 3 ft.	2 Dug 4 ft.	3 Dug $4\frac{1}{2}$ ft.	4
Mould (soil in 4)		$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$1\frac{1}{2}$
[Alluvium.]	Brown clay (sandy in 3)	$8\frac{1}{2}$	6	5	5
	Blue clay (and mud in 2)...	6	7	2	29
	Black compost [? peaty earth] ...	$\frac{1}{2}$	$\frac{1}{2}$	—	—
	Grey sand	—	—	—	$23\frac{1}{2}$
	Sand and clay ...	$26\frac{1}{2}$	18	19	7
	Grey sand	25	6	$22\frac{1}{2}$	—
Total ...		67	38	49	66
Depth of water-level...		19	14	$14\frac{1}{2}$	14

Chadwell St. Mary's.

Ordnance Map 271, new ser. (Essex 89, NW.).
Communicated by J. H. Greathead.

Boring at 'World's End' Tavern by the shore, eastward of Tilbury Station, which, with the Docks, is not in Tilbury parish.

		Thickness. Ft.	Depth. Ft.
Soil ...		2	2
[Alluvium.]	Clay	3	5
	Mud	20½	25½
	Peat	9	34½
	Mud	7	41½
	Peat	4	45½
	Silt	12	57½
	Peat	2	59½
[River] Gravel		1½	61

Boring between Railway Street and 'World's End' Tavern.
Communicated by J. H. Greathead.

		Thickness. Ft.	Depth. Ft.
Soil ...		1	1
[Alluvium.]	Clay	2½	3½
	Mud	12½	16
	Peat	8½	24½
	Mud and silt	28½	53
[River] Gravel		—	—

Dagenham.

Ordnance Map 257, new ser.
Marsh. Western side of Creek (Dagenham Breach) and by side of Thames.
6·9 ft. above Ordnance Datum.
From a MS. Book of Borings in the Engineer's Office, Metropolitan Board of Works. (No. 14.)

		Thickness. Ft.	Depth. Ft.
[Alluvium, 16 ft.]	Yellow clay	3	3
	River-mud, with water	4	7
	Peat	9	16
[Valley Drift and Lower London Tertiaries ?]	Silty, running sand and water	6	22
	Green, silty sand and water	6	28
	Gravelly sand and gravel	6	34
	Rough, shingly gravel	16	50
	Muddy sand and water, with small pebbles	13	63

East Ham Level.

Ordnance Maps 257, 271, new ser.

Beckton Gas Works.

Four borings, communicated by Mr. J. Pitter. These borings are in a part of the Thames Marshes, which, although on the northern side of the river, really belongs to Kent.

1. (In the river-bed) 100 ft. from River Bank, 12 ft. below T.H.W.M.

		Thickness. Ft. In.	Depth. Ft. In.
[Alluvium.]	Mud	16 0	16 0
	Peat	7 8	23 8
	Silt	2 8	26 4
[River Gravel]	Ballast	9 6	35 10
[Thanet Sand, 8 ft.]	Silty Clay	5 2	41 0
	Sand	2 10	43 10
Chalk		6 0	49 10

East Ham Level, cont.

2. (On the river bank) 15 ft. from the water's edge, 1 ft. below T.H.W.M.

		Thickness. Ft.	In.	Depth. Ft.	In.
[Alluvium.]	Mud...	17	6	17	6
	Peat	9	0	26	6
	Silty clay	3	11	30	5
[River Gravel] Ballast		18	4	48	9
Dark green [Thanet] Sand, to Chalk.		20	3	69	0

3. 200 ft. from the water's edge, slightly above T.H.W.M.

		Thickness. Ft.	In.	Depth. Ft.	In.
[Alluvium.]	Mud ...	11	10	11	10
	Peat ...	16	0	27	10
	Clay ...	1	5	29	3
[River Gravel] Ballast ...		19	9	49	0
[Thanet Sand] Silt, to Chalk		37	3	86	3

4. 504 ft. from the water's edge, 7 ft. below T.H.W.M.

		Thickness.	Depth.
Soil		1	1
[Alluvium, $21\frac{3}{4}$ ft.]	Clay	$8\frac{3}{4}$	$9\frac{3}{4}$
	Peat	$10\frac{1}{4}$	20
	Silty Sand ...	$2\frac{3}{4}$	$22\frac{3}{4}$
[River Gravel] Ballast		$28\frac{1}{4}$	51
Green, silty [Thanet] Sand, to Chalk ...		24	75

North Woolwich.

Communicated by J. H. Greathead.

1. At south-eastern corner of field, west of the G.E.R. Station. Over 14 ft. above Ordnance Datum.

		Thickness. Ft.	Depth. Ft.
Soil and made ground		5	5
[Alluvium, 23 ft.]	Mud	9	14
	Clay	$2\frac{1}{2}$	$16\frac{1}{2}$
	Peat	3	$19\frac{1}{2}$
	Loam	4	$23\frac{1}{2}$
	Peat	$3\frac{1}{2}$	27
	Mud	1	28
[River Drift]. Sand and fine gravel ...		$21\frac{3}{4}$	$49\frac{3}{4}$
White chalk, with few flints		15	$64\frac{3}{4}$

2. Foreshore of the Thames, 60 yds. south of No. 1. Over 2 ft. below Ordnance Datum.

Mud and peat ...	9	32 ft. to Chalk.
Sand and gravel ...	23	

North Woolwich Railway Station.

Shaft for proposed tunnel under the Thames. 1883?
Communicated by Mr. T. A. Walker.
Over 7 ft. above high-water of Spring tides.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Clay	$16\frac{3}{4}$	$16\frac{3}{4}$
	Peat	3	$19\frac{3}{4}$
River] Gravel	... ...	30	$49\frac{3}{4}$
[Upper Chalk.]	Chalk	11	$60\frac{3}{4}$
	Flints	1	$61\frac{3}{4}$
	Loose chalk	3	$64\frac{3}{4}$
	Flints	$\frac{1}{2}$	$65\frac{1}{4}$
	Loose chalk, full of water	$2\frac{1}{4}$	$67\frac{1}{2}$
	Hard chalk, with 3-in. beds of flints at the top and at the bottom	$5\frac{1}{4}$	$72\frac{3}{4}$

Silvertown.

Trial borings at Prince Regent's Wharf, near North Woolwich. 1872.
Made and communicated by Messrs. TILLEY.

	1.	2.	3. (in the tide-way.)
[Alluvium] Mud	29	29	23
[River] Gravel	5	6	5

Gas Light and Coke Company. 1881.
Trial boring (No. 1). Made and communicated by Messrs. TILLEY.

		Ft.	Ins.	
[Alluvium.]	Mould	1	—	15 ft. 2 ins.
	Yellow clay	4	—	
	River mud and peat ...	6	—	
	Peat	4	2	

East Tilbury.

Ordnance Map 272, new ser.

Borings, made for the War Office at Coalhouse Fort, show that there is silt and mud to the depth of 53 ft.

Elsenham.

Borings in the Hall Park.
Made and communicated by Mr. G. INGOLD.

a. East end of park.
Boulder Clay, 40 ft.

b. Near the house.

Boulder clay	$18\frac{1}{2}$	$31\frac{1}{2}$ ft.
Red and yellow sand ...	13	

c. In paddock, south of the house.

Loam	6	30 ft.
Red and yellow sand ...	24	

Epping.

Ordnance Map 240, new. ser.
Four trials at Epping Green.
Made and communicated by Mr. G. INGOLD.

	Near School.	Near Chapel.	Vicarage.	N. side of Road.
Boulder Clay ...	16	16	18	18
London Clay ...	9	9	10	4

Grays.

Ordnance Map 271, new ser. (Essex 83, SE.).
New Pier. 1868.
Bored and communicated by Messrs. TILLEY.

[Alluvium.]	Mud ...	3	$22\frac{1}{2}$ ft.
	Peat ...	$10\frac{1}{2}$	
	Blue sand ...	3	
[River] Gravel, to Chalk ...		6	

Grays, cont.

Three trial-borings in the Marsh. 1891.

Communicated by W. H. Radford.

a. Nearly an eighth of a mile south of the Brewery.

[Alluvium.]	Stiff clay ...	4	28 ft.
	Soft clay ...	11	
	Peat ...	8	
[River] Gravel	... ...	5	

b. About a sixth of a mile southward of the Brewery, and south-east of *a.*

[Alluvium.]	Clay ...	10	18 ft.
	Soft mud ...	4	
	Clay ...	4	
[River] Gravel.			

c. Less than half-a-mile south-south-east of the Brewery, and over half-a-mile south-south-west of Little Thurrock Church.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Brown clay ...	4½	4½
	Brown peat ...	1	5½
	Blue clay ...	15	20½
	Black peat ...	7	27½
	Blue clay ...	8	35½
	Black peat ...	4	39½
[River] Gravel	... ...	1½	41

Messrs. H. and W. Gibbs' Pulp Works. 1886.

Made and communicated by Messrs. Le Grand and Sutcliff.

Made ground and rubbish	14	40 ft.
Chalk and flints	26	

Hornchurch Sluice, 1839.

Ordnance Map 257, new ser.

Communicated by J. B. Redman.

Surface of Apron 15 ft. below T.H.W.M.

[Alluvium.]	Peat	10	14½ ft. to gravel.
	Light, soft Clay	3	
	Dark, silty Clay	1½	

Lea Bridge, 1854.

Ordnance Map 256.

Borings made and communicated by Messrs. T. Docwra and Son.

Nos. 1 to 5, 8, 10, 11.

[Alluvium.]	Yellow clay, 1½ to 3½.
	Blue clay, 0 to 3.
	Peat, 0 to 8.
[Valley Drift.]	Black gravel, 10½ in No. 1, touched in the rest.
	Red gravel, 3, in No. 1.

Nos. 6 and 7, showed only 3 ft. of yellow clay above black gravel.

No. 9.

		Thickness. Ft.	Depth. Ft.
[Alluvium, 4 ft.]	Yellow clay	2½	2½
	Blue clay	1½	4
[Valley Drift, 9 ft.]	Black gravel	4½	8½
	Grey gravel	4½	13
[? Lower London Tertiaries.]	Coloured [mottled] sand ...	6	19
	Grey sand	6½	25½
	Green sand, to dark sand ...	11	36½

Navestock.

Ordnance Map 257, new ser.

Tan House Farm. 1891.

Made and communicated by Mr. G. INGOLD.

Brown Clay ...	9	33 ft.
London Clay ...	24	

Prittlewell.

For Messrs. Bird and Co. 1876.

Made and communicated by Messrs. DOCWRA and SON.

		Thickness. Ft.	Depth. Ft.
Surface soil	... ...	$3\frac{1}{2}$	$3\frac{1}{2}$
[Drift, 6 ft.]	Sand	$2\frac{1}{2}$	6
	Ballast [gravel] ...	$3\frac{1}{2}$	$9\frac{1}{2}$
[London Clay.]	Yellow clay ...	15	$24\frac{1}{2}$
	Loamy clay ...	1	$25\frac{1}{2}$
	Blue clay ...	6	$31\frac{1}{2}$

Radwinter.

Ordnance Map 205 or 222, new ser.

Cowlass Hall. 1892.

Made and communicated by Mr. G. INGOLD.

	1.	2.	3.	4.
Brown clay	2	5	6	7
Sand	$\frac{1}{2}$	—	—	—
Loose chalky clay... ...	—	2	—	—
Brown clay	4	—	—	—
Blue clay	11	12	12	11
Total ...	$17\frac{1}{2}$	19	18	18

Rainham.

Ordnance Map 257, new ser. (Essex 82, NE.).

1. Near the railway-station. Two borings.

	Thickness. Ft.	Depth. Ft.
Mould	1	1
Brown clay	2	3
Light-brown clay	2	5
Loamy sand	2	7
Black peat	1	8
Live grey sand	8	16
Live sand and pebbles ...	26	42
Coloured sands and stone ...	6	48

	Thickness. Ft.	Depth. Ft.
Mould	1	1
Brown clay	2	3
Light-brown clay	2	5
Black peat	4	9
Loamy sand	3	12
Running sand...	7	19
Ballast [Gravel]	5	24
Running sands	7	31

Rainham, cont.

2. City Corporation Wharf.
Made and communicated by Messrs. Isler and Co.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Thames dredgings	9	9
	Clay and mud	3	12
	Peat	10	22
	Clay and peat	$8\frac{1}{4}$	$30\frac{1}{4}$
[? River Drift.]	Ballast [Gravel]...	1	$31\frac{1}{4}$
	Sand	$1\frac{3}{4}$	33
	Ballast	9	42
	Mud and sand	1	43
	Sand	4	47
	Fine ballast	10	57
	Concrete [? concreted gravel] ...	$\frac{1}{2}$	$57\frac{1}{2}$

? Depth from surface, 65 ft.

Southend.

Ordnance Map 258, new ser. (Essex 78, SE.).
Gasworks, Lower Southend. Westward of the old Gas-holders and Storehouse.
10 borings, made and communicated by Messrs. Docwra.

[Alluvium.]	Soil, or sand (thin) and clay	$10\frac{1}{2}$ to $12\frac{1}{2}$
	Peat (mostly $2\frac{1}{2}$ ft.)	$1\frac{1}{2}$ to $2\frac{1}{2}$
[River Drift.]	Ballast [gravel] and sand (in one case 10 ft.)	$\frac{1}{2}$ to $2\frac{1}{2}$

To [London] Clay, and in two cases $4\frac{1}{2}$ to 5 ft. in it.

Pier.

Five borings. Made and communicated by Messrs. Docwra.

1. 200 ft. from inside face of brickwork, back of entrance and 7 ft. westward of edge of piles.

Mud	1	15 ft.
Hard blue [London] Clay ...	14	

2. By Octagon, 6 ft. west from angle of Band-stand, 350 ft. from No. 1.
Hard blue [London] Clay, 15 ft.

3. 11 ft. westward of pier, 2,020 ft. from No. 2.

[River-deposit.]	Sand	7	15 ft.
	Cockle shells and sand	1	
Soft blue [London] Clay		7	

4. 7 ft. westward of pier, 2,000 ft. from No. 3.

Mud and cockle-shells ...	3	20 ft.
Blue clay and sand ...	17	

5. Head of pier.

Sand and mud ...	1	$25\frac{1}{2}$ ft.
Blue clay and sand ...	$24\frac{1}{2}$	

? Stanford le Hope.

Sea Reach (of the old map, not named on the new one, 258, new ser.), near low-water-mark of Spring-tides.
Piles for a lighthouse on the foreshore of the Thames. About 1850.
Sir J. N. Douglass, *Proc. Inst. Civ. Eng.*, vol. ci, p. 47.
[Alluvium.] Mud, loam and sand, to compact shingle [gravel ?], 56 ft.

Stanford Rivers.

Ordnance Map 240, new ser. (Essex 50, SE.).
Toot Hill. About $1\frac{1}{2}$ miles north-west of the church. 1871.
Eight borings. Made and communicated by Messrs. Tilley.

To blue [London] Clay [through Boulder Clay ?]	16 to 30 ft.
In ,, ,, ,, ...	4 ,, 40 ,,
Total depth	22 ,, 70 ,,

In one case 4 ft. of silt recorded above the blue clay.

Weeley.

Ordnance Map 224, new ser. (Essex 38, NW.). Geologic Map 48, SW.

For the Eastern Counties Coal Boring Association. On the northern side of the little stream about 100 yds. north-east of the railway station. Finished in 1896.

Made and communicated by VIVIAN'S BORING Co. (with remarks from specimens, chiefly by A. J. JUKES-BROWNE).

Diamond-boring began at 730 ft.

		Thickness. Ft.	Depth. Ft.
Soil		1	1
[London Clay, 124 ft.]	Sandy clay	1½	2½
	Clay	1	3½
	Shale and clay	3	6½
	Blue shale	48½	55
	Blue sandy shale	4½	59½
	Grey sandy shale	23½	83
	Grey sandy clay	40	123
	[Basement-bed.] Grey clay and cobbles [pebbles]	1	124
	[Basement-bed.] Grey clay and small flint-stones [pebbles]	1	125
[Reading Beds, (? and Thanet) 71 ft.]	Yellow clay, very solid	3	128
	Brown pinnel	30	158
	Green sand	22	180
	Brown sandy clay	16	196
[Upper Chalk, 420½ ft.]	Chalk and flint-stones	½	196½
	Grey [?damp] chalk, with ten layers of flints	169½	366
	White chalk, with 32 layers of flints	250½	616½
[Middle] Grey chalk, with flints in nine layers (greyish, streaky at 634½ ft.; cream-coloured and whitish at 647½; nearly white at 680, 700 and 720; soft and white at 730; marl-band at 736-37; soft and white at 740; rough, nodular, with dark grey patches, at 788; from 836 down rough, nodular and shelly in parts, and with grey veins in parts, (Melbourne Rock ?)		228½	845
[Lower Chalk, 173½ ft.]	Grey marly chalk (pale greenish chalk, chalk with greenish and grey veins, and pale greenish marl [=Belemnite Marl], the greenish tints fading after a long time	6½	851½
	Grey chalk (greenish and white, laminated, marly, at 853; light-greenish-grey flaky marl, certainly Belemnite Marl, at 854, 854½; firm, nearly white, at 855; firm, whitish at 864 and 884	32½	884
	Grey marly chalk (firm, whitish, at 900)	24	908
	Grey marl (hard greyish-white chalk at 922; firm light-grey chalk at 940 and 953)	48½	956½
	Grey marly chalk (Chalk Marl, mostly compact; friable at 1,000)	49	1,005½
	Grey marl (compact and flaky at 1,013)	11	1,016½
	Green sand and pebbles (dark greenish glauconitic marl, phosphatic nodules)	2	1,018½
[Gault, 76 ft.]	Gault (grey shaly clay at 1,027; more compact grey clay at 1,032)	17½	1,036
	Green sand and pebbles (stiff glaucomitic clay, with black phosphatic nodules)	2½	1,038½
	Gault (smooth grey clay at 1,040)	56	1,094½

Weeley, cont.

		Thickness. Ft.	Depth. Ft.
[? Silurian.] or Cambrian ?	Grey sandy shale	5	1,099
	Broken grey sandy shale (at 1,120 compact dark grey slate, cleavage-planes well-marked, at 85° from horizontal)	62	1,161½
	Jointy grey sandy shale	38½	1,200
	Undescribed	21½	1,221½

The word shale, applied to the London Clay, must allude merely to the fissile character of the clay, along planes of bedding; the shale of the old rock at the bottom is a different thing. The cores of this are of hard stone, often much disturbed, crushed and folded. The bedding of these is at a high angle, and this was thought to be in a southerly direction. No fossils have been found, therefore one can do no more than class them as Silurian.

There seems to be some doubt as to the depth 851½, which perhaps should be 854½.

It is said that when in 'soft gault' there was trouble from a large quantity of some kind of gas, which made the water 'boil up' in the hole.

The following fossils were recorded by A. J. Jukes-Browne:— *Holaster globosus* at 884 ft., *Ammonites Mantelli* and *Turrilites tuberculatus* at 999 ft.; many specimens of *Avicula gryphaeoides*.

M. Mourlon wrote that samples of the old rock resemble the Cambrian of Belgium, especially the Revinian division.

Prof. W. W. Watts thinks that the old rock has "its closest parallel in that underlying the fossiliferous Cambrian rocks at the Spinney Hills, Leicestershire." (*Geol. Mag.*, 1915, pp. 198, 199.)

West Ham.

Ordnance Map 257, new ser.

1. Stratford. Messrs. Winstones' Works, Reynolds Estate.

Made by Messrs. Docwra, 1876. Communicated by Mr. B. Winstone.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Puddled	—	6
	Muddy clay	3	9
	Boggy soil (peat) ...	3	12
	Sandy clay	3	15
[River Gravel.]	Ballast	24	39
[?London.]	Clay	6	45

2. Distillery. 1861.

Boring made and communicated by Messrs. T. Docwra and Son.

		Thickness. Ft.	Depth. Ft.
Gravel and sand		16	16
[?Lower London Tertiaries.]	Yellow clay ...	2	18
	Running sand ...	17	35
	Blue clay ...	2	37

West Thurrock.

Ordnance Map 271, new ser.

Purfleet. On the works of the Steamship Owners' Coal Association.

Communicated by Mr. J. H. Anderson.

A. At approach to Purfleet Pier.

		Thickness. Ft.	Depth. Ft.
	Mixed filling	10	10
	Soft filling	10	20
	Stiffer filling	3.34	23.34
[Alluvium.]	Peat	5.16	28.5
	Blue clay	3.83	32.33
	Stiff blue clay...	7.67	40
	Peat and mud	2	42
	Peat	1	43
[River Drift.]	Rough ballast [gravel] ...	4	47
	Fine dirty ballast	3	50
	Clean sandy ballast	11.5	61.5
	Chalk	5.5	67

B. On sea-wall 640 ft. nearer Grays.

	Gaswork-refuse	14	14
[Alluvium.]	Brown clay	1	15
	Stiff mud	7	22
	Peat	$12\frac{1}{2}$	$34\frac{1}{2}$
	Mud and peat...	$7\frac{1}{2}$	42
	Black peat	$1\frac{1}{2}$	$43\frac{1}{2}$
[River Drift.]	Running sand...	$1\frac{1}{2}$	45
	Fine dark ballast	20	65
	Chalk	2	67

ANALYSES OF SPRING WATERS.

We have a fair number of analyses of waters from springs, and besides those given under this heading a few have been tabulated with neighbouring well-waters, for the purpose of ready comparison, as will be seen from the cross-references or the Index, under Springs.

Many analyses of so-called mineral waters have been given by Miss May Thresh, in the work she did with Mr. M. Christy, which has been referred to on pp. 51, 52. These having been so lately published are not included here; but the reader is referred to the original.

Some few analyses now given, however, would justify the inclusion of the waters, whether from springs or wells, amongst mineral waters, as much as in the cases which have been so honoured. The definition of a mineral or medicinal water is somewhat loose: some folk say that it depends on the nastiness. Strictly, perhaps, water is itself a mineral: certainly all waters contain a good deal of what is usually called mineral matter; but the adjective is used in connection with water only when there is an unusual amount of some substance in the water, giving this an exceptional (and generally a medicinal) character.

Asheldham.

Southminster Public Supply, see p. 73.
Sample from Water Tower, Asheldham. By Dr. J. C. Thresh.
20th April, 1912.

In parts per 100,000

Ca.	2·5	Probably combined as :—	
Mg.	·6	Calcium carbonate	1·
Na.	2·3	Calcium sulphate	3·4
CO_3	·6	Calcium chloride	3·
SO_4	2·4	Magnesium chloride	2·3
Cl.	3·5	Sodium nitrate	8·5
NO_3	6·2	Etc.	·3

Total solid constituents dried at 180° C., 18·5.
Hardness, Total, 12°.

Free ammonia	·004
Organic ammonia	·002
Oxygen absorbed in 3 hours at 37° C. ...	·016
Nitrites	nil·

Clear and bright. Excellent appearance. Very faint yellow. No odour. Reaction neutral.

An analysis of about 1900 shows a total solid contents of 20, a total hardness of only 8°, and other slight differences.

Braintree.

Surface-springs. Made by Thomas Spencer. November, 1852.

	In parts per 100,000.
Carbonate of lime	14·57
,, magnesia ...	3·
Sulphate of lime	3·14
Chloride of sodium	3·86
Silica	1·57
Iron and alumina	2·14
Organic matter	1·71
Total solid contents	30·

Braintree, cont.

	In parts per 100,000.
Total solid contents by experiment after filtration	29·06
Hardness, Clark's scale	15·2°
Hardness, after boiling 10 minutes	7·6°

Clear and bright. Well aerated. Well flavoured. Had very little matter in suspension.

Chelmsford.

Admiral's Park spring, see pp. 74, 370, 371.

Two analyses, *A*.—By [Sir] E. FRANKLAND. August, 1896. *B*.—By Dr. J. C. THRESH. 22nd November, 1911, when it was the supply taken for the North Ward of Chelmsford. Sample taken at Admiral's Park.

	A	B	In parts per 100,000.	A	B
Ca.	—	13·6	Probably combined as :—		
Mg.	—	·9	Calcium carbonate ...	—	30
Na.	—	2·8	Calcium sulphate... ...	—	5·4
CO_3	—	18	Magnesium sulphate ...	—	3·
SO_4	—	6·2	Magnesium chloride ...	—	1·2
Cl.	2·8	3·3	Sodium chloride	—	3·9
*NO_3	(·213)	3·6	Sodium nitrate	—	4·9
*N(as nitrates)	·048	(·81)	Etc.	—	·6
					(Dried at 180° C.)
			Total solids	43·4	49
			Hardness : Temporary ...	23·2	22°
			Permanent ...	4·3	10°
			Total	27·5	32°
			Ammonia : Free	·002	·001
			,, Organic	—	·006
			Oxygen absorbed in 3 hours at 37° C.	—	·028
			Nitrites	—	Nil

* In *A*. nitrates are indicated as Nitrogen in Nitrates and Nitrites; In *B*. as NO_3. The figures in brackets are calculated from the other asterisked figure in the same column for comparison.

A.—Though of very high organic purity, is partly derived from impure sources and is not to be recommended for dietetic purposes unless coming from a deep well (100 ft. or more). Would require filtration on account of turbidity.

B.—Clear and bright. No deposit. Very faint yellow. No odour. Reaction neutral.

Analyses of Burgess Well springs and Harrington's Garden springs are given on pp. 370, 371.

Coggeshall.

St. Peter's Well. By J. C. THRESH. 2nd June, 1912.

		In parts per 100,000.	
Ca.	12·3	Probably combined as :—	
Mg.	·65	Calcium carbonate	29·3
Na.	4·85	Calcium sulphate	2·05
CO_3	17·6	Magnesium sulphate ...	3·25
SO_4	7·4	Sodium sulphate	5·
Cl.	3·1	Sodium chloride	5·1
NO_3	3·7	Sodium nitrate	4·9
		Silica, etc.	·4
		Total solid constituents dried at 180° C.	50·
		Hardness Total	31°

Coggeshall, cont.

	In parts per 100,000.
Free ammonia	·000
Organic ammonia	·005
Oxygen absorbed in 3 hours at 37° C. ...	·008
Nitrites	Nil.

Clear and bright. No odour. Reaction neutral.

Colchester.

Spring at foot of town. From gravel over London Clay. *Sixth Rep. Riv. Poll. Comm.* 1874, p. 127.

Temperature centigrade, 8·9°.

2nd April, 1873.	In parts per 100,000
Total solid impurity	154·7
Organic carbon	·176
Organic nitrogen	·057
Ammonia	·001
Nitrogen as nitrates and nitrites	7·395
Total combined nitrogen	7·453
*Previous sewage or animal contamination ...	73640·
Chlorine	27·5

Hardness: Temporary, 18·9; permanent, 34·1. Total 53.

Clear and palatable.

* An old term, not now used, based on the idea that all nitrates and ammonia are derived from sewage. See p. 13 of the Report.

One of several polluted spring-waters, of which some, including this one, are specially mentioned as dangerous to health if used for domestic purposes. Also, it is excessively hard for washing purposes.

It appears, at the time of analysis, to have been in use by the public.

For Colchester Public Supply, from springs, see pp. 75, 76, 78, 79.

Copford.

Copford Rectory. In the garden a spring rises in a small pond. The water was taken to the house in galvanised iron pipes. By Dr. J. C. Thresh. 26th June, 1912.

			In parts per 100,000.
Ca.	12·3	Probably combined as :—	
Mg.	·7	Zinc carbonate	2·2
Zn.	1·1	Calcium carbonate	28·8
Na. & K.	2·75	Calcium sulphate	2·6
CO_3	18·3	Magnesium sulphate ...	3·5
SO_4	4·6	Sodium chloride	5·3
Cl.	3·2	Potassium nitrate	1·6
NO_3	1·	Silica, etc.	1·7
		Total solid constituents dried at 180° C.	45·7

Hardness: Temporary, 23°; permanent, 4° Total 27°

Free ammonia	·000
Organic ammonia	·011
Oxygen absorbed in 3 hours at 37° C. ...	·064
Nitrites	Nil.

The zinc must be derived from the galvanized pipes.

Danbury.

Buell Springs. On the Common. Taken for Public Supply of **Danbury**, see pp. 76, 77. Sample from a tap by the roadside.
By Dr. J. C. Thresh. 15th April, 1912.

In parts per 100,000

Ca.	3·1	Probably combined as :—	
Mg.	·56	Calcium carbonate	2·5
Na.	1·55	Calcium sulphate	5·95
CO_3	1·5	Calcium chloride	·97
SO_4	4·2	Magnesium chloride	2·16
Cl.	2·6	Sodium chloride	·63
NO_3	3·5	Sodium nitrate	4·8
		Etc.	·29
		Total solid constituents dried at 180° C. ...	17·3

Hardness Total 10°

Free ammonia	·001
Organic ammonia	·002
Oxygen absorbed in 3 hours at 37° C. ...	·02
Nitrites	Nil.

Clear. Good appearance. No deposit. Faint yellow. No odour. Reaction neutral.

Felstead.

Felstead springs. Public supply, see p. 77.
From house-tap (near Felstead School). By Dr. J. C. Thresh.
23rd November, 1911.

In parts per 100,000

Ca.	17·8	Probably combined as :—	
Mg.	·7	Calcium carbonate	33·3
Na.	2·5	Calcium sulphate	12·3
CO_3	20	Calcium chloride	2·4
SO_4	8·7	Magnesium chloride	2·7
Cl.	5·4	Sodium chloride	3·1
NO_3	3·6	Sodium nitrate	4·9
		Silica, etc.	1·3
		Total solids (Dried at 180° C.)	60·

Hardness: Temporary, 26·5; permanent, 13·5. Total 40

Free ammonia	·000
Organic ammonia	·0028
Nitrites	·000

Clear and bright, no deposit. Very faint yellow. No odour. Reaction neutral.

Great Baddow.

Chelmsford Rural District Council's Waterworks springs, see p. 77.
By Dr. J. C. Thresh. 9th April, 1912.

In parts per 100,000

Ca.	4·6	Probably combined as :—	
Mg.	1	Calcium carbonate	4
Na.	2·4	Calcium sulphate	10·2
CO_3	2·4	Magnesium sulphate ...	·75
SO_4	7·8	Magnesium chloride	3·35
Cl.	3·4	Sodium chloride	1·5
NO_3	4·9	Sodium nitrate	6·7
		Etc.	·3
		Total solid constituents dried at 180° C.	26·8

Hardness: Total 18°

Great Baddow, *cont.*

	In parts per 100,000
Free ammonia	·001
Organic ammonia	·002
Oxygen absorbed in 3 hours at 37° C. ...	·02
Nitrites	Nil.

Great Bentley.

1. From land-drain piping spring in Holly Wood.

2. Spring in Admirals Farm.

These waters are used for the supply of Clacton.

By Dr. J. C. Thresh. 19th to 21st October, 1897.

	In parts per 100,000 1.	2.
Physical Characters.	Clear, bright, colourless.	Very clear. Yellow.
Chlorine	4·86	3·29
Nitrates	1·14	·71
Nitrites	0	0
Free ammonia	0	·007
Albuminoid ammonia	·005	·018
Total hardness (per 100,000) ...	10·	9·3
Temporary hardness (per 100,000) ...	2·1	4·3

1. Admirable water. Collecting area satisfactory. Supply could be so protected as to be quite safe.

2. Contains some organic matter, derived from vegetable matter growing in bed of stream. The small amount of nitrates and of chlorine shows that the spring when cut back will yield very good water.

3. Sample from tap off main in Clacton. By Dr. J. C. Thresh.

November, 1911.

			In parts per 100,000
Ca.	3·6	Probably combined as :—	
Mg.	1·2	Calcium carbonate ...	2·5
Na.	3·2	Calcium sulphate ...	8·8
CO_3	1·5	Magnesium sulphate ...	3·76
SO_4	9·2	Magnesium chloride ...	1·72
Cl.	3·9	Sodium chloride... ...	4·32
NO_3	4·5	Sodium nitrate	5·6
		Etc.	·3
		Total solid constituents dried at 180° C.	27·

Hardness, temporary, 3°; permanent, 13°. Total ... 16°

Free ammonia	·001
Organic ammonia	·0055
Oxygen absorbed in 3 hours at 37° C. ...	·036
Nitrites	Nil.

Great Waltham.

Springs taken for Public Supply (Chelmsford Rural District Council), see p. 78.

By Dr. J. C. Thresh. *A*, about 1900; *B*, 18th April, 1912.

In parts per 100,000.

	A.	B.		A.	B.
Ca.	—	15	Probably combined as :—		
Mg.	—	·3	Calcium carbonate	—	27·7
Na.	—	1·3	Calcium sulphate ...	—	10·2
CO_3	—	16·6	Calcium chloride ...	—	2·5
SO_4	—	7·2	Magnesium chloride ...	—	1·1
Cl.	2·4	2·4	Sodium nitrate... ...	—	4·8
NO_3	2·7	3·5	Etc.	—	·7
			Total solid constituents dried at 180° C. ...	48	47
			Hardness ... ... Total	38°	38°
			Free ammonia	·0	0
			Organic ammonia	·004	·002
			Oxygen absorbed in 3 hours at 37° C.	·056	·02
			Nitrites	Nil.	Nil.
			Carbonic acid gas (CO_2)	—	·66

Lexden.

Springs for Colchester Supply, see pp. 78, 79.

Sample from Lexden Spring Reservoir. By J. C. Thresh.

11th November, 1911.

In parts per 100,000.

Ca.	3·5	Probably combined as :—	
Mg.	1·	Calcium carbonate ...	2·5
Na.	·8	Calcium sulphate ...	3·
CO_3	1·5	Calcium chloride ...	4·4
SO_4	2·1	Magnesium chloride ...	1·7
Cl.	4·1	Magnesium nitrate ...	3·6
NO_3	5·2	Sodium nitrate ...	3·
		Etc.	·8
		Total solid constituents dried at 180° C.	19·

Hardness: Temporary, 1·5°; permanent, 12°—Total ... 13·5

Free ammonia	·001
Organic ammonia	·002
Oxygen absorbed in 3 hours at 37° C. ...	·027
Nitrites	Nil.

Clear and bright. No deposit. Very faint yellow. No odour. Reaction neutral.

Newport, see p. 423.

Purleigh and District, see **Woodham Walter,** p. 363.

St. Osyth.

Spring-outlet. Dunnet's Seed Farm. By Dr. J. C. THRESH.

19th-21st October, 1897.

Physical Characters. Clear, bright, colourless.

	In parts per 100,000
Chlorine	6·57
Nitrates	2·29
Nitrites	0
Free ammonia	0
Albuminoid ammonia	·008
Total hardness (per 100,000) ...	18·6
Temporary ,, ,, ...	7·9

Not quite so good as some Great Bentley springs examined at same time (see p. 350), the Chlorine and Nitrates being higher owing to part of collecting area being highly manured (manure spread on site of spring). With the site cleared and area around protected water will be as pure as that from the Great Bentley springs mentioned above.

Southminster (Public Supply), see **Asheldham.**

Terling.

By Prof. J. T. WAY. Rivers Pollution Commission. 1868.

A.—Public spring. Near 'Rayleigh Arms.' 28th February, 1868.

B.—Spring at Norrell's. 28th February, 1868.

C.—Terling Place (Lord Rayleigh's). Spring feeding a large pond. April, 1868.

In parts per 100,000, except Hardness, which is in grains per gallon degrees.

	A.	B.	C.
Mineral residue	40·7	35·9	38·3
Chloride of sodium	3·64	4·27	4·36
Hardness: Permanent (In degrees) ...	1·89	2·44	2·72
Temporary ,, ,, ...	20·26	18·73	20·95
Total ,, ,, ...	22·15	21·17	23·67
Nitrogen from ammonia	·0075	0	—
Ammonia	—	—	·006
Nitrogen from albuminous matter ...	·007	·002	—
Albuminous matter	—	—	·04
Nitrogen from nitric acid	·545	·641	—
Nitric acid	—	—	2·43

A.—An excellent water. Similar to *B*, and only inferior to *B* in containing somewhat more Ammonia and Albuminous matter, which, however, are not sufficient to cause doubt as to freedom from pollution. Its hardness suggests a Chalk source.* Fit for domestic purposes.

B.—Though hard, of excellent quality, containing a minimum of Ammonia and animal organic matter. Evidently from the Chalk.* In every respect fitted for human consumption.

C.—Hard, but not more so than most Chalk springs. In all probability comes direct from the Chalk* and 'would form a most desirable source of supply for drinking purposes.'

It was analysed with five well-waters (see pp. 445, 446), and was 'far the best of the series.'

* None of these three waters can come from the Chalk, but probably get their calcareous character from Boulder Clay.

Tiptree.

Springs taken for Public Supply, see p. 81. Sample from a hydrant at boundary of Tolleshunt D'Arcy. By Dr. J. C. Thresh. 1st April, 1912.

		Probably combined as:—	
Ca.	2·4	Calcium carbonate	4·5
Mg.	·5	Calcium sulphate	2·
Na.	2·2	Magnesium sulphate	2·
CO_3	2·7	Magnesium chloride	·4
SO_4	3·	Sodium chloride	3·8
Cl.	2·6	Sodium nitrate	2·7
NO_3	2·	Etc.	·1
		Total solid constituents dried at 180° C.	15·5

Hardness—Total ... 9°

Free ammonia	·001
Organic ammonia	·0025
Oxygen absorbed in 3 hours at 37° C.	·032
Nitrites	Nil

An excellent water for domestic purposes, but found to have an action on iron and galvanised iron pipes.

Wickham Bishop, see p. 461.

Woodham Walter.

Spring for Purleigh and District Waterworks, see p. 82.
Sample from a tap at a cottage. By Dr. J. C. Thresh. 15th April, 1912.

		Probably combined as:—	In parts, per 100,000
Ca.	2·9	Calcium carbonate	5·5
Mg.	·4	Calcium sulphate	2·4
Na.	1·59	Magnesium sulphate	1·
CO_3	3·3	Magnesium chloride	·8
SO_4	2·5	Sodium chloride	2·14
Cl.	1·9	Sodium nitrate	2·75
NO_3	2·	Etc.	·41
		Total solid constituents dried at 180° C.	15·
		Hardness	10°

Free ammonia	·001
Organic ammonia	·002
Oxygen absorbed in 3 hours at 37° C.	·016
Nitrates	nil.

Differs but slightly from an earlier analysis (? about 1900).

Writtle.

Dr. Thresh, in a Report (1891) on the village of Writtle and Oxney Green, which is quoted on pp. 59, 60, says, "Writtle village stands upon a patch of Glacial gravel. At the edges there are numerous springs. The analyses of five of these are given as being typical of what the water from this gravel patch should be." They are compared with 50 analyses of 47 well-waters from the district, very unfavourably to the wells.

ANALYSES OF WELL WATERS.

A great number of published analyses have been got together, many of which are of an imperfect kind; but a goodly number are complete, enabling us to know something of the mineral contents of the waters, a matter of importance, the organic purity not being the only point on which knowledge is wanted.

Some of these are old analyses, referring to a past state of things; but it has been thought well to include them, as dealing with the history of water-supply and showing the progress that has been made. In a few cases the old analyses may serve to point out where improvement is needed.

Many unpublished analyses have been added, and these are mostly such as give the information from which the mineral contents of the water can be made out. It is largely through one of the authors having been for a long time the Medical Officer of Health for Essex that this detailed information can be given. He has a great number of analyses not given here, including every public well in the county and many private wells.

The alphabetic arrangement, by names of places, is followed here, as in the previous divisions of the Memoir.

For convenience figures not originally in parts per 100,000 have been converted to that denomination in nearly all cases.

Abberton.

By Dr. J. C. Thresh.

A.—Pantile Farm. 1st boring. 24th April, 1911. See p. 85.
B.—Pantile Farm. 2nd boring. 3rd November, 1911. See p. 86.
C.—Abberton Hall. 15th February, 1908. See p. 85.

In parts per 100,000.

	A	B	C	Probably combined as :—	A	B	C
Ca.	2·4	6·75	2·	Calcium carbonate ...	6	16·85	5
Mg.	1	3·65	1·35	Magnesium carbonate	3·46	4·75	4·75
Na.	56·97	121·1	64·25	Magnesium sulphate	—	11·5	—
CO_3	·22·4	13·5	19·4	Sodium carbonate ...	28·84	—	23·05
SO_4	8·	150	10·	Sodium sulphate ...	11·8	208·4	14·8
Cl.	62·6	82·5	76	Sodium chloride ...	103·2	136	125·4
NO_3	·19	—	—	Sodium nitrate ...	·26	0	0
Fe	—	—	Very minute trace.	Silica, etc.	·94	·5	1·

	A	B	C
Total solid constituents dried at 180° C. ...	154·5	378	174
Hardness: Temporary ...	11°	—	—
Permanent ...	4°	—	—
Total ...	15°	—	8·5°
Free ammonia	·116	—	·08
Organic ammonia	·002	—	·003
Oxygen absorbed in 3 hours at 37° C. ...	·072	—	—
Nitrites	nil	—	nil
Turbidity	A little sand.	Faint	Slightly dull.
Colour	Grey.	Slightly yellow.	—
Odour	none.	none.	—
Reaction	Alkaline.	Neutral	—

Althorne.

A.—Summerhill. 24th December, 1897. See p. 87.

B.—Great Eastern Railway station. 17th November, 1909. See p. 86.

By Dr. J. C. THRESH.

	A	B
Ca.	36·2	14·8
Mg.	24·4	8·6
Na.	35·55	38·7
CO_3	13·8	17·6
SO_4	161	81·6
$Cl.^-$	54·7	29·9
NO_3	·4	·66
PO_4	trace	—

	In parts per 100,000 A	B
Probably combined as :—		
Calcium carbonate	23·	29·3
Calcium sulphate	92·	7·6
Magnesium sulphate ...	120·6	42·5
Sodium sulphate	—	59·2
Sodium chloride	90·1	49·3
Sodium nitrate	·55	·9
Silica, etc.	1·75	1·2
Total solid constituents dried at 180° C. ...	328	190
Hardness :— Total ...	+100°	88°
Free ammonia	·004	·003
Organic ammonia	·012	·008
Oxygen absorbed in 3 hours at 37° C. ...	·13	·14
Nitrites	nil.	nil.

Ardleigh.

1. Well at Phoenix Mill.
2. Bore-tube at Phoenix Mill, see p. 87.
3. Shallow well at Railway Tavern, adjoining Mill.
4. Shallow well at Merchant's Cottage, Station Road, about 250 yds. above Phoenix Mill, see p. 87.

By Dr. J. C. THRESH. 19th to 21st October, 1897.

In parts per 100,000.	1	2	3	4
Physical characters ...	Clear, bright, colourless.	Turbid with iron-oxide.	Clear, bright, colourless.	Clear, very yellow.
Chlorine	4·14	4·57	4·71	20·04
Nitrates as Nitrogen	1·54	—	1·71	8·57
Nitrites	0	0	0	traces
Free Ammonia	·002	·003	0	·04
Albuminoid ammonia	·006	·009	·007	·038
Total hardness (per 100,000) ...	11·43	—	13·6	50·
Temporary hardness (per 100,000)	3·57	—	2·9	4·3

1. Very satisfactory. Very little organic matter, and that probably because well is unprotected. If properly constructed and protected the well would yield very pure water in considerable quantities. (The Chlorine did not increase after six days' continuous pumping, which shows that any impurity from the direction of 4 must be enormously diluted.)

2. Had been standing for months in plugged pipe and contained much iron-oxide in suspension. Result, total destruction of Nitrates and analysis of no value.

3. Fairly satisfactory. Nitrates a little higher than in 1, showing that subsoil is a little more polluted.

4. Very impure; a dilute sewage. Doubtless due to manurial matter on garden around; but the subsoil must be highly impregnated with sewage, some, possibly, from sewer-outfall close by.

Aveley.

Aveley Hall, Marshfoot Farm. Well pumped into ditch for use of cattle. (See p. 89.) By Dr. J. C. THRESH. 18th November, 1909.

In parts per 100,000

Ca.	13·5	Probably combined as :—	
Mg.	1·1	Calcium carbonate	18·5
Na.	2·6	Calcium sulphate...	12·5
CO_3	11·1	Calcium chloride	6·7
SO_4	8·8	Magnesium chloride	2·8
Cl.	6·4	Magnesium nitrate	2·4
NO_3	9	Sodium nitrate	9·6
		Silica, etc.	·5
		Total solid constituents dried at 180° C.	53
		Hardness—Temporary 16° ; Permanent 18° Total	34°
		Free ammonia	·000
		Organic ammonia	·004
		Oxygen absorbed in 3 hours at 37° C. ...	·036
		Nitrites	Nil

Very clear and bright. Almost colourless. No odour.

Barking.

1. Analyses from the East London Co.'s (now Metropolitan Water Board) wells.

A.—(?known as the East Ham well.) (?of 1899.) 6th April, 1899. See p. 90.

B.—Well (? of 1899). 11th July, 1899.

C.—Well (? of 1899). 5th April, 1910.

By Dr. J. C. THRESH.

C is very similar in all respects to an analysis in Dr. HOUSTON's Report to the Metropolitan Water Board for 1910, p. 51. Date of analysis, 5th January, 1910.

	A	B	C	In parts per 100,000.	A	B	C
Ca.	2·1	2·6	3·5	Probably combined			
Mg.	·4	1·25	1·7	as :—			
Na.	12·8	11·15	12·4	Calcium carbonate ..	5·25	6·5	8·75
CO_3	12·6	13·95	14·1	Magnesium carbonate	1·4	4·35	5·9
SO_4	6·65	6·1	7·4	Sodium carbonate ..	14·9	12·25	8·25
Cl.	4·2	4·4	7·9	Sodium sulphate ...	9·85	9·	10·9
NO_3	1·1	·27	·56	Sodium chloride	6·95	7·25	13·
				Sodium Nitrate ...	1·5	·4	·76
				Silica, etc.	1·65	1·25	·44
				Total solid constituents dried at 180° C. ...	41·5	41·	48·
				Hardness—Temporary	—	7·8°	12
				Permanent	—	·7°	4
				Total	7°	8·5°	16
				Free ammonia	—	·05	·064
				Organic ammonia	—	·000	·001
				Oxygen absorbed in 3 hours at 37° C ...	—	·013	·028
				Nitrites	—	nil	nil

A.—Clear and bright. *C.*—Clear. Faint yellow. No odour.

There is a notable change in *C*, there being a continuous increase in Chlorides and Magnesium Salts attributable to the drawing in of a little tidal water.

Barking, cont.

2. From seven Barking wells.

A.—Glenny's Brewery. (Well 320 ft. deep.) March, 1889. See p. 91.

B.—Glenny's Brewery. (Well 320 ft. deep.) 10th April, 1899.

C.—Messrs. White and Co.'s Mineral Water Works. Axe (? St. Anne's) Street. (Well 582 ft. deep.) 30th April, 1899. See p. 91.

D.—Messrs. Gross, Sherwood and Heald. (4-in. bore, 450 ft. deep.) 16th September, 1912. See p. 92.

E, *F*, *G*.—Barking Creek and Creekmouth, near the Thames.

E.—Lawes' Manure Works. (200 ft. deep.) May, 1898. See p. 92.

F.—De Pass' Manure Works. (The 350 ft. boring of about 1893.) May, 1898. See p. 93.

G.—De Pass' Manure Works. (The 140 ft. well of 1912.) September, 1912. See p. 93.

By Dr. J. C. Thresh. In parts per 100,000

	A	B	C	D	E	F	G
Ca.	2·2	1·35	1·6	1·8	12	12·1	29·6
Mg.	·8	·75	·25	1·7	5·1	6·2	25
Na.	16·9	14·95	16·2	13·15	30·1	44·45	257·7
CO_3	15·	13·7	14·	14·1	17·8	16·9	19·8
SO_4	6·2	7·7	8·7	5·7	10·5	7·8	57·6
Cl.	5·45	5·5	5·4	7·	53·4	82·	456
NO_3	·75	·4	·4	·15	·53	·35	·5

Probably combined as :—	A	B	C	D	E	F	G
Calcium carbonate ...	5·5	3·4	4·	4·5	29·8	28·2	33·
Calcium sulphate... ...	—	—	—	—	—	2·7	55·8
Magnesium carbonate ...	2·7	2·6	·85	5·9	—	—	—
Magnesium sulphate ...	—	—	—	—	13·1	7·4	22·8
Magnesium chloride ...	—	—	—	—	9·9	18·55	79·8
Sodium carbonate ...	17·3	17·3	19·4	13	—	—	—
Sodium sulphate ...	11·8	11·4	12·85	8·45	—	—	—
Sodium chloride	9·	9·1	8·9	11·55	75·9	112·45	654·1
Sodium nitrate	1·	·55	·55	·2	·7	·5	·7
Silica, etc.	·9	1·15	·95	1·4	·6	·2	3·8
Total solid constituents dried at 180° C... ...	48·2	45·5	47·5	45·	(Dried at 220°) 130	170	850
Hardness: Temporary ...	—	5°	5°	—	—	26°	—
Permanent ...	—	2°	3°	—	—	37°	—
Total ...	—	7°	8°	11°	—	63°	280°
Free ammonia	·002	·062	·056	·02	·08	·1	·64
Organic ammonia	·029	0	·006	·002	·015	·022	·011
Oxygen absorbed in 3 hours at 37° C	—	·014	·053	·016	·112	·132	·24
Nitrites	—	nil	nil	nil	nil	nil	nil

B.—No turbidity. Clear, bright and colourless.
D.—Clear. Dull. Nearly colourless. No odour. Reaction neutral.
E.—Quite turbid from presence of iron oxide.

3. Barking Mills. Deep well into Chalk. See pp. 89, 90.

Analysis by G. W. Wigner. 1878.

	In parts per 100,000
Total solid matter	46·14
Loss on ignition	2·14
Total mineral matter	44·
Chlorine (calculated as Chloride of Sodium) ...	9·5
Iron	trace.
Alkaline salts	25·74

Barking, cont.

	In parts per 100,000
Nitrogen as ammonia	·0446
,, ,, albuminoid ammonia	·0051
,, ,, nitrates	·0214
,, ,, nitrites	trace.
Oxygen absorbed by organic matter	·0029

Colour in two-foot tube, opaque yellow.
Organic matter, slight traces. Suspended matter [? ditto].
Smell when heated to 100° F., satisfactory.
Taste ,, ,, ,, good.
Hardness, before boiling, 5·2°; after boiling, 2.3°.

Regarded as a first-class water.

4. Farmhouse on Barking Farm. From the *Sixth Rep. Riv. Poll. Comm.* 1874, p. 88.

A shallow well in alluvium and gravel. 9th November, 1871.

	In parts per 100,000.
Total solid impurity	143·6
Organic carbon	·625
Organic nitrogen	·13
Ammonia	0
Nitrogen as nitrates and nitrites	8·569
Total combined nitrogen	8·699
*Previous sewage or animal contamination ...	85370
Chlorine	20·1

Hardness:—Temporary 4·3; permanent 62·8; total 67·1.

Slightly turbid.

* For explanation of previous sewage contamination, see **Colchester,** p. 348.

This sample was one of many from Alluvium and Gravel on which the general remarks were to the effect that they could not be used for domestic purposes without much risk to health, that the animal organic matter polluting them had been to a great extent destroyed by oxidation, and that they were wasteful for washing purposes on account of extreme hardness. [This sample appears to be one of the worst of the series.]

Berners Roding or Roothing.

Berners Hall. Bored well (320 ft. deep) of 1912. 9th November, 1912. After 14 hours' test-pumping. By Dr. J. C. Thresh.

			In parts per 100,000
Ca.	·8	Probably combined as:—	
Mg.	·35	Calcium carbonate	2·
Na.	29·09	Magnesium carbonate	1·21
CO_3	16·8	Sodium carbonate	26·07
SO_4	12·5	Sodium sulphate	18·51
Cl.	18·1	Sodium chloride	29·85
NO_3	0	Sodium nitrate	0
		Silica, etc.	1·36
		Total solid constituents dried at 180° C. ...	79·
		Hardness:—Total ...	4°
		Free ammonia	·072
		Organic ammonia	·005
		Oxygen absorbed in 3 hours at 37° C. ...	—
		Nitrites	Nil

Dull. Some sand in suspension. Greyish. No odour. Reaction neutral.

Billericay.

Slyce's Gate. Boring made in 1904 for the Billericay Rural District Council. Taken over by Southend Water Co., see p. 95.

By Dr. J. C. Thresh. *A*, 1st July, 1904. *B*, 14th January, 1909. *C*, 14th June, 1910.

In parts per 100,000

	A	B	C		A	B	C
Ca.	·7	·7	·7	Probably combined as :—			
Mg.	·8	·25	·16				
Na.	28·85	29·55	29·94	Calcium carbonate	1·75	1·75	1·75
CO_3	17·9	16·9	18·4	Magnesium carbonate	2·8	·85	·55
SO_4	6·3	6·3	8·8	Sodium carbonate	26·3	26·95	29·96
Cl.	22·1	22·8	19·7	Sodium chloride ...	36·45	37·6	32·4
NO_3	0	·15	·12	Sodium sulphate ...	9·35	9·3	13·
				Sodium nitrate ...	0	·2	·16
				Silica, etc.	1·35	1·35	1·18

		A	B	C
Total solid constituents dried at 180° C. ...		78·	78·	79·
Hardness :	Temporary	3°	—	—
	Permanent	2°	—	—
	Total	5°	3°	2·8
Free ammonia		·006	·068	·06
Organic ammonia		·002	·003	·002
Oxygen absorbed in 3 hours at 37° C. ...		·013	·024	·044
Nitrites		nil	nil	nil

A.—No turbidity. Clear and bright. Bluish-green. No odour.

C.—Dull. Colour, dull yellow. No odour.

Of *A* he says :—It contains no trace of Iron, nor any objectionable saline constituent. Is typical of the best class of waters from the Chalk in central Essex. Practically free from organic matter and undoubtedly an excellent water for a public supply.

Bocking.

1. Five analyses. Waterworks (Braintree Rural District Council).

A.—The boring 504 ft. deep of 1907 or 1908. 31st December, 1907 (? when the bore was only 400 ft. deep). Abandoned. Supply not sufficient. See p. 100.

B.—The boring 325 ft. deep of 1911. 25th May, 1911. See p. 100.

C.—Water [from upper beds] coming into a well being made round the bore-hole of 1911. 11th July, 1912.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	C	Probably combined as :—	A	B	C
Ca.	5·2	8·75	2·8	Calcium carbonate ...	13·	21·87	7
Mg.	4·6	1·4	·5	Magnesium carbonate	13·9	4·84	1·73
Na.	16·9	14·81	19·44	Magnesium sulphate..	2·9	—	—
CO_3	17·7	17·65	18·3	Sodium carbonate ...	—	1·9	22·77
SO_4	8·2	6·1	8·	Sodium sulphate ...	8·7	9·	11·84
Cl.	21·4	17	8·6	Sodium chloride ...	35·3	28·04	14·2
NO_3	·5	·09	·26	Sodium nitrate ...	·7	·15	·36
				Etc.	·5	1·2	·1

		A	B	C
Total solid constituents dried at 180° C. ...		75	67	58
Hardness :	Temporary	—	19°	—
	Permanent	—	6°	—
	Total	25°	25°	10·7°
Free ammonia...		·08	·057	·068
Organic ammonia		·002	·003	·004
Oxygen absorbed in 3 hours at 37° C. ...		·076	·046	·064
Nitrites		nil	nil	ni

Bocking, cont.

B.—Clear and bright. Very slightly yellow. No odour.

C.—Somewhat turbid (fine sand deposit). Greyish. No odour.

2. Analyses from two Bocking wells.

A.—Dr. Taylor's well (271 ft. deep). June, 1899. See pp. 97, 98.

B.—Messrs. Courtauld's Crêpe Mills. (Well of 1865, 244 ft. deep.) See pp. 98, 99. 26th November, 1900.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	8·1	8·45	Calcium carbonate	20·25	21·15
Mg	3·6	3·6	Magnesium carbonate ...	9·65	7·7
Na.	9·9	9·35	Magnesium sulphate ...	4·25	7·
Fe.	·15	—	Sodium sulphate	6·5	1·5
CO_3	19·2	18·2	Sodium chloride	19·8	22·45
SO_4	7·8	6·6	Ferrous carbonate	·3	—
Cl.	12	13·6	Aluminia oxide	1·3	3·2
NO_3	·1	—	Silica, etc.	·95	
Total solid constituents dried at 180° C.				63	63·
Hardness—			Temporary	—	21°
			Permanent	—	18°
			Total	27° ?	39°
Free ammonia				·04	·044
Organic ammonia				·001	·01
Oxygen absorbed in 3 hours at 37° C.				·016	·039
Nitrites				minute trace.	nil

A.—Turbid. Becomes very opalescent and yellow-brown in 2 or 3 hours. Faint odour. The upper 40 ft. of well are lined with uncemented bricks and the well is close to the house drains.

Bowers Gifford.

Pumping Station. Southend Water Co., see p. 101.
By Dr. J. C. Thresh. 14th January, 1909.

14th January, 1909.

In parts per 100,000

		Probably combined as :—	
Ca.	·8	Calcium carbonate ...	2·
Mg.	·2	Magnesium carbonate ...	·7
Na.	29·8	Sodium carbonate ...	26·15
CO_3	17·6	Sodium sulphate ...	13·
SO_4	8·8	Sodium chloride	36·45
Cl.	22·1	Silica, etc.	1·7
NO_3	0		
Total solid constituents dried at 180° C.			80·
Hardness :—		Total ...	3·5°
Free ammonia			·048
Organic ammonia			·001
Oxygen absorbed in 4 hours at 27° C.			·038
Nitrites			nil.

Braintree.

1. Trial-boring at the waterworks. Analysis by THOMAS SPENCER. 1854.

	In grains per gallon.
Sulphate of Soda	24·86
,, Magnesia	3·64
Nitrate of lime	4·41
Chloride of sodium	16·43
Carbonate of soda	3·76
Carbonate of lime	11·96
Peroxide of iron	·114
Silica, with a trace of alumina ...	2·87
Organic matter and loss	3·73
Total [the figures add up to 71·774]	105·71
Hardness, Clark's scale	10·2°
Hardness after boiling 10 minutes	5·5°

Though for dietary purposes none of the mineral matters can be termed 'absolutely unwholesome,' the aggregate amount of them is so large that he cannot recommend the water for the domestic supply of a town.

He refers to the waters of Trafalgar Square and the well at the railway-station, Camden Town, as not unlike this water, though they contain less solid matter, and says that neither of these are recommended for domestic use.

He thinks it might improve with free pumping.

[Ideas have changed since this analysis was made, and such waters are now largely used for all domestic purposes and are found to be perfectly wholesome.—J. C. T.]

2. Well at waterworks (430 ft. deep), see p. 103. From the *Sixth Rep. Riv. Poll. Comm.*, 1874, p. 103. 3rd April, 1873.

	In parts per 100,000
Temperature centigrade, 12·2°	
Total solid impurity	106·7
Organic carbon	·068
Organic nitrogen	·033
Ammonia	·094
Nitrogen as nitrates and nitrites	0·
Total combined nitrogen	·11
*Previous sewage or animal contamination ...	450
Chlorine	38·8
Hardness:—Temporary, 8·7; permanent, ·5; total, 13·7	

Clear and palatable.

* For explanation of previous sewage contamination, see **Colchester,** p. 348.

This sample is one of 13 from deep wells in the Chalk beneath London Clay. It contains the highest proportion of any of them of total solids, 106·7, the lowest being 33·38, and the average being 78·09. The presence in such water of dissolved salts (largely sodium chloride generally, and frequently sodium bicarbonate) to a greater amount than is found in Chalk-waters not capped by the Clay is commented on, and it is remarked that these saline impurities are not objectionable if not present in excessive quantity. 'Excessive quantity' being defined as approaching 100 parts per 100,000 or 70 grains per gallon.

The purity of the waters generally is well spoken of.

Braintree, cont.

3. Public supply. See p. 103.

Three samples from taps at the works, or on mains. No. 1 practically direct from the well.

By T. A. Pooley, September, 1891. Dr. Reece's Report to the Local Government Board, No. 282, 1907.

Parts per 100,000

	No. 1	No. 2	No. 3
Total solids	109·	108·	109·07
Lime (Ca. O)	3·36	not determined.	
Magnesia (Mg. O)	3·46		
Phosphates	none	none	none
Sulphuric acid (SO_3)	6·6	not determined.	
Chlorine	41·43	41·27	41·17
Equal to chloride of sodium	68·27	68·01	67·8
Nitrogen as nitrates	·021	·0116	·0223
Equal to nitric acid	·0944	·052	·1003
Saline ammonia	·088	·0794	·079
Albuminoid ammonia	·0039	·0039	·0044
Oxygen absorbed from permanganate in 15 minutes	·0134	·0049	·0184
Ditto in 4 hours	·0211	·0271	·0249

Hardness, before boiling, 11° in all; after boiling, 3° in all.

Physical Examination.—All bright, almost colourless, devoid of taste or smell, slightly alkaline to test-papers and distinctly so after boiling.

Nos. 1, 3. No appreciable quantity of sediment after standing 24 hours.

No. 2. A very small quantity of sediment after standing 24 hours.

Microscopic Examination of the sedimentary matter collected after some days. In No. 1 the quantity was very minute and no moving organisms or any animal or vegetable debris found. In No. 2 the sedimentary matter more distinct, mainly of mineral substances, but with some moving organisms and some vegetable and animal fibres. In No. 3 very slight sediment and no moving organisms found, only a few minute fibrous particles.

These results show that the three samples are practically identical and represent a very pure water. The albuminoid ammonia and the oxygen absorbed are exceptionally small and show that the water is remarkably free from dissolved organic matter, whilst the almost absence of nitrates is further evidence of organic purity. The very large amounts of free ammonia and chlorides are remarkable; these however are not unusual in waters from the beds between the London Clay and the Chalk.

4. Waterworks.

A, B, C.—Well near railway-station (sunk 1888), about 330 ft. deep (known as No. 2 well).

A.—25th January, 1899. *B.*—From tap at Vestry Hall, 26th January, 1912. *C.*—Direct from well, 23rd July, 1912.

By Dr. J. C. Thresh.

Braintree, cont.

	A	B	C	In parts per 100,000	A	B	C
Ca.	1·9	2·1	2·	Probably combined as:—			
Mg.	1·45	1·6	1·6				
Na.	38·8	38·94	39·9	Calcium carbonate	4·75	5·25	5·
CO_3	17·2	18·3	18·3	Magnesium carbonate	5·1	5·54	5·5
SO_4	7·8	8·	8·1	Sodium carbonate ..	18·9	19·83	20·2
Cl.	41·4	40·7	42·	Sodium sulphate ...	11·5	11·84	12·
NO_3	·08	·13	0·	Sodium chloride ...	68·3	67·13	69·2
				Sodium nitrate ...	·95	·18	0
				Silica, etc.		·23	·1
				Total solid constituents dried at 180° C.	109·5	110	112
				Hardness: Temporary ...	13°	15·4°	16·5°
				Permanent ...	·4°	·6°	·5°
				Total ...	13·4	16°	17°
				Free ammonia	·08	·028	·112
				Organic ammonia	·005	·0015	·0055
				Oxygen absorbed in 3 hours at 37° C. ...	·062	·019	·038
				Nitrites	nil	very minute trace.	nil

A.—No turbidity. Clear, bright and colourless.
B.—No deposit. Very clear, bright. Very slightly greyish. No odour.
C.—Clear. Of good appearance. Faint grey. No odour.

5. Town well. Public supply, see p. 103. By Dr. J. C. Thresh. May, 1909.

		Probably combined as:—	In parts per 100,000
Ca.	·75	Calcium carbonate ...	1·85
Mg.	·45	Magnesium carbonate ...	1·55
Na.	34·95	Sodium carbonate ...	28·55
CO_3	18·3	Sodium sulphate ...	26·3
SO_4	17·8	Sodium chloride	35·6
Cl.	21·6	Sodium nitrate, etc. ...	1·15
NO_3	·15		
		Total solid constituents dried at 180° C.	95·

Hardness ... 5°
Free ammonia ... ... ·08
Organic ammonia ... ... ·004
Oxygen absorbed in 3 hours at 37° C. ... ·06
Nitrites ... ... nil

The well is in Chalk. Water from the Thanet Sand was getting in and the sample was specially taken. The analysis shows this (Thanet Sand) water to be practically identical with water from the Chalk.

6. Messrs. Courtauld's in (Braintree) town, near the river (321 ft. deep), see p. 103.
By Dr. J. C. Thresh. 22nd December, 1900.

		Probably combined as:—	In parts per 100,000
Ca.	2·1		
Mg.	2·	Calcium carbonate ...	5·25
Na.	38·6	Magnesium carbonate ...	7·
CO_3	19·4	Sodium carbonate ...	19·85
SO_4	9·2	Sodium sulphate ...	13·6
Cl.	39·2	Sodium chloride	64·7
NO_3	·3	Sodium nitrate	·4
		Etc.	2·2
		Total solid constituents dried at 180° C. ...	113·
		Hardness: Total	12°

Braintree, cont.

	In parts per 100,000
Free ammonia	·088
Organic ammonia	·001
Oxygen absorbed in 3 hours at 37° C. ...	·024
Nitrites	nil.

Brentwood.

A.—Asylum. 25th July, 1899. See pp. 104, 105.
B.—Merry Mead or Merrimead boring. 18th August, 1913. See p. 105.
By Dr. J. C. Thresh.

	A	B	Probably combined as :—	A	B
				In parts per 100,000	
Ca.	·6	·65	Calcium carbonate ...	1·5	1·65
Mg.	·3	·3	Magnesium carbonate	1·05	1·
Na.	24·7	25·15	Sodium carbonate ...	28·15	29·9
CO_3	17·6	18·6	Sodium sulphate ...	13·6	14·2
SO_4	9·2	9·6	Sodium chloride ...	20·3	19·1
Cl.	12·3	11·6	Sodium nitrate ...	·3	·2
NO_3	·22	·15	Silica, etc.	·6	·55
			Total solid constituents dried at 180° C.	65·5	66·6
			Hardness : Temporary ...	2°	1·75°
			Permanent ...	0·5°	1·
			Total ...	2·5°	2·75°
			Free ammonia	·02	·0664
			Organic ammonia	·000	·0048
			Oxygen absorbed in 3 hours at 37° C. ...	·08	·056
			Nitrites	nil	nil

A.—Quite clear and bright.

Another sample taken, 4th July, 1900, when there had been an outbreak of typhoid, agrees very closely with the above, Ammonia, free, ·056, and organic ·0028, being the two most noticeable divergencies.

The water had nothing to do with the typhoid outbreak.

B.—Faintly opalescent. Yellow tint. No odour. Reaction neutral.

Brightlingsea.

Three analyses of the public supply. By Dr. J. C. Thresh.

A.—Boring (made 1899). 11th July, 1899. See p. 106.
B.—Second boring. 12 ft. from the other. 25th November, 1903. Much fine sand is raised in this bore, which consequently does not yield so freely as the other.
C.—From a tap supplied by the waterworks (a mixture of *A* and *B*). 18th December, 1911.

	A	B	C	Probably combined as :—	A	B	C
					In parts per 100,000		
Ca.	3·2	3·7	3·5	Calcium carbonate	8·	9·2	8·75
Mg.	1·4	2·4	2·	Magnesium carbonate	4·9	8·4	6·9
Na.	18·35	16·1	18·66	Sodium carbonate ..	17·2	12·2	15·15
K.	—	·4	—	Sodium sulphate ...	4·95	5·9	5·2
CO_3	18·1	18·4	18·7	Sodium chloride ...	23·6	22·7	25·9
SO_4	3·35	4	3·5	Sodium nitrate ...	·2	—	·6
Cl.	14·3	13·8	15·7	Potassium nitrate ...	—	·65	—
NO_3	·15	·25	·44	Silica, etc.	1·65	·95	·5
				Total solid constituents dried at 180° C ...	60·5	60	63
				Hardness : Temporary ...	10°	16·4°	16·5°
				Permanent ...	1·5°	1°	·5°
				Total ...	11·5°	17·4°	17°
				Free ammonia	·076	·068	·000
				Organic ammonia	·002	·000	·003
				Oxygen absorbed in 3 hours at 37° C. ...	·012	·017	·029
				Nitrites	nil	nil	nil

Brightlingsea, cont.

C.—Clear and bright. Excellent appearance. Very faint yellow. No odour. Reaction neutral.

The following, dealing with an old state of things, is from G. W. WIGNER'S Water Supply of Sea-side Watering Places, 1878, pp. 20, 21.

The supply was taken from a well about $1\frac{1}{2}$ miles from the sea and said to be only 18 ft. deep. Sample drawn from the mains.

	In parts per 100,000
Total solid matter	48·
Loss on ignition, after deducting combined carbonic acid ...	22·56
Iron	heavy.
Chlorine, calculated as chloride of sodium	10·7
Hardness before boiling, Clark's scale	8·5°
,, after boiling, Clark's scale	7·8°
Nitrogen as ammonia	·0017
,, albuminoid ammonia	·005
,, nitrates	2·56
,, nitrites	·014
Total nitrogen in the four forms	2·582
Oxygen absorbed by organic matter	·021

Water pale blue. Fair taste. Slight smell when heated. Microscopic examination satisfactory. The excess of nitrates most likely due to manured fields.

Broomfield.

1. The 1911 bore of Chelmsford Rural District Council. See p. 107.

A.—Sample on the fourth day of trial-pumping. 15th August, 1911.

B.—Twelfth day of trial-pumping. 23rd August, 1911.

By Dr. J. C. THRESH.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	·72	·66	Calcium carbonate ...	1·8	1·65
Mg.	·3	·3	Magnesium carbonate	1·04	1·04
Na.	40·35	40·41	Sodium carbonate ...	34·98	35·67
CO_3	21·6	21·9	Sodium sulphate ...	8·9	8·3
SO_4	6·	5·6	Sodium chloride ...	56·4	56·4
Cl.	34·2	34·2	Sodium nitrate ...	·18	·06
NO_3	·13	·05	Silica, etc.	1·2	·88
			Total solid constituents dried at 180° C.	104·5	104·
			Hardness: Temporary	—	5·7°
			Permanent	—	0
			Total	6·4°	5·7°
			Free ammonia	·08	·08
			Organic ammonia	·001	·000
			Oxygen absorbed in 3 hours at 37° C. ...	·048	·056
			Nitrites	nil	nil

A.—Very dull and turbid. A little sand in suspension. Yellowish grey. No odour.

B.—Dull, slightly greyish. No odour.

Broomfield, cont.

2. From two other Broomfield Wells.

C.—Broomfield Hall. May, 1909. See p. 107.

D.—Shallow well at back of Phillibrows Cottages (in gravel). 3rd April, 1909. See p. 108. This is in a manured garden and corresponds to a strong purified sewage.

By Dr. J. C. Thresh.

In parts per 100,000

	C	D
Calcium carbonate	2·4	20·5
Calcium sulphate	—	54·5
Calcium chloride	—	24·1
Magnesium carbonate ...	1·2	—
Sodium carbonate	40·2	—
Sodium sulphate	12·	—
Sodium chloride	32·35	—
Sodium nitrate	—	45·5
Potassium nitrate	—	5·85
Calcium nitrate	—	4·9
Magnesium nitrate	—	18·5
Silica, etc.	1·85	*6·15
Total solid constituents	90·	180
Hardness	6°	150°+
Free ammonia	·08	·013
Albuminoid ammonia ...	·002	·038
Oxygen absorbed	·068	·4

D.—Dull and yellow. Reaction neutral.

* Organic matter, silica, phosphates, etc.

Bulmer.

A.—Auberies. Well over 80 ft. deep, in sand. 3rd January, 1913.

B.—Smeetham Hall. Deep well in Chalk. 3rd January, 1913.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	8·1	13·	Calcium carbonate ...	18·5	30
Mg.	·62	·5	Calcium sulphate ...	2·38	1·98
Na.	2·5	2·42	Calcium chloride ...	—	1·16
CO_3	11·1	18·	Magnesium sulphate	3·04	—
SO_4	4·1	1·4	Magnesium chloride	—	1·95
Cl.	2·7	3·1	Sodium chloride ...	4·45	1·5
NO_3	2·04	4·9	Sodium nitrate ...	2·79	6·72
			Etc.	1·84	·69

	A	B
Total solid constituents dried at 180° C.	33·	44·
Hardness: Temporary	16°	26°
Permanent	8°	7°
Total	24°	33°
Free ammonia	·000	·000
Organic ammonia	·004	·002
Oxygen absorbed in 3 hours at 37° C. ...	·032	·032
Nitrites	nil	nil

A.—Clear and bright, little matter in suspension (short fibres, fine sand, etc.). Faint yellow. No odour. Reaction neutral.

B.—Clear and bright. Little matter in suspension (fine sand, etc.). Very faint yellow. No odour. Reaction neutral.

Bulphan.

By Dr. J. C. Thresh.

A. and *B.*—See p. 109, for sections.

		In parts per 100,000		
	A 11th July, 1899. Bulphan Fen. Overflowing bore fitted to cattle-troughs by the roadside.	B 8th August, 1900. Bulphan Fen. Near Wick House.	C April, 1898. Bulphan Fen. Beerhouse.	D 10th October, 1911. Bulphan Fen. At cottage. 25 ft. deep. (Probably from Oldhaven Beds.)
Calcium carbonate	4·25	29·3	3·65	22·1
Calcium sulphate	—	114·9	—	76·2
Magnesium carbonate	3·15	—	1·25	—
Magnesium sulphate	—	362·5	—	127·4
Magnesium chloride	—	45·5	—	—
Sodium carbonate	19·4	—	18·65	—
Sodium sulphate	14·2	—	26·95	50·9
Sodium chloride	8·1	231·	27·7	128·6
Sodium nitrate	·4	1·5	—	·3
Silica, etc....	·5	33·3	1·3	1·5
Total solid constituents dried at 180° C.	50·	818·	79·5	407·
Hardness: Temporary	6·5°	—	6°	—
Permanent	1·5°	—	1·5°	—
Total	8°	over 400	7·5°	over 200°
Free ammonia	·056	·002	·005	·014
Albuminoid ammonia	·001	·003	·305	·016
Oxygen absorbed...	·061	nil	·05	·204
Nitrites	nil	—	nil	nil

D.—Caused diarrhœa. Doubtlessly B would also do so if used for drinking purposes.

Burnham.

Waterworks (old well, before 1896). Communicated by W. T. FOXLEE.

	In parts per 100,000
Chlorine as chlorides	5·
Nitrogen as nitrates	1·13
Sulphuric anhydride as sulphates ...	4·8
Total solids	43·
Hardness before boiling, 21°; after boiling, 11·7°.	
Saline ammonia	·002
Organic ammonia	·004

Waterworks (newer than the above). See p. 110.

Three analyses by Dr. J. C. THRESH.

A, Old shallow well (about 1900). *B*, New bored well, 1901, 6th December, 1902. *C*, same. 5th December, 1911.

	B	C	A
Ca.	·62	1·3	—
Mg.	·4	·8	—
Na.	44·9	41·4	—
CO_4	22·3	22·4	—
SO_3	8·5	6·4	—
Cl.	38·6	37·3	4·7
NO_3	·14	0	4·4

In parts per 100,000

Probably combined as :—	B	C	A
Calcium carbonate...	1·5	3·25	—
Magnesium carbonate	1·4	2·77	—
Sodium carbonate ..	36·1	32·68	—
Sodium sulphate ...	12·6	9·4	—
Sodium chloride ...	63·7	61·5	—
Sodium nitrate ...	1·2	0	6
Silica, etc.		·4	—
Total solid constituents dried at 180°C.	116·5	110·	—
Hardness : Temporary	3·5°	6°	7°
Permanent	·5°	—	7°
Total	4°	6°	14°
Free ammonia	·000	·05	·000
Organic ammonia	·001	·002	·003
Oxygen absorbed in 3 hours at 37° C. ...	·048	·043	·152
Nitrites	nil	trace	nil

A.—Bright, clear and colourless. Good gravel-water.

C.—Clear and bright. Very faint yellow. No odour.

Canewdon.

A.—Pudsey Hall. October, 1909. See p. 111.

B.—Mr. G. Pettitt's well, Toftmans Farm. February, 1889. See p. 111.

C.—Public well in Canewdon village. 1st December, 1899. See p. 111.

By Dr. J. C. THRESH.

In parts per 100,000.

	A	B	C
Calcium carbonate	34·1	1·5	2·75
Calcium sulphate	45·9	—	—
Magnesium carbonate	—	1·75	2·1
Magnesium sulphate	33·1	—	—
Sodium carbonate	—	32·6	31·6
Sodium sulphate	30·9	11·1	12·9
Sodium chloride	57·7	56·9	62·7
Sodium nitrate	29·1	·2	—
Potassium nitrate	—	—	1·7
Silica, etc.	2·2	1·95 (some organic matter)	1·25
Total solid constituents	(dried at very dull redness.) 233	(dried at 180° C.) 106	(dried at 180° C.) 115
Hardness :	—	Temporary 1·5°	5·5°
	—	Permanent 1·5°	2·5°
	Total 130°	Total 3°	8°
Free ammonia	·028	·084	·0
Organic ammonia	·054	·01	·002
Oxygen absorbed in 3 hours at 37° C. ...	·4	·056	·056
Nitrites	Slight trace.	nil	nil

A—Analysis shows the presence of some sub-soil-water. It contained some potassium, not determined.
C—On Nov. 28th, 1899, a sample was slightly dull and after a time yielded a slight ferruginous deposit.

Canvey.

Public well. Near the church. See p. 112.

By Dr. J. C. Thresh. 5th November, 1900.

In parts per 100,000

Ca.	·9	Probably combined as :—	
Mg.	·35	Calcium carbonate ...	2·25
Na.	34·2	Magnesium carbonate ...	1·25
CO_3	16·6	Sodium carbonate ...	25·35
SO_4	8·5	Sodium chloride	48·5
Cl.	29·4	Sodium sulphate ...	12·6
NO_3	·3	Sodium nitrate	·4
		Difference	·15
Total solid constituents dried at 180° C. ...			90·5

Clear and bright. Colour normal. No odour. Reaction alkaline.

Chelmsford.

1. Waterworks. See pp. 116, 117.

By Mr. Carter, Med. Off. Health, in Dr. R. J. Reece's Report to the Local Government Board, 1896.

	1 Deep Well, Mildmay Road.		2 Burgess Well Springs.		3 Admiral's Park Springs.	
	Nov., 1892.	Nov., 1895.	Oct., 1892.	Oct,. 1895.	Oct., 1892.	Oct., 1895.
	Parts per 100,000.					
Nitric nitrogen	·157	·229	·987	·987	·4	·657
Nitrites	nil	nil	nil	nil	nil	nil
Chlorine	28·67	30·	3·	3·43	3·	3·
(=Chloride of Sodium)	(46·71)	(49·86)	(4·86)	(5·57)	(4·86)	(4·86)
Hardness (degrees) ...	2	3·5	21·5	24	21·5	22
	Parts per million.					
Free ammonia	·48	·62	·03	·028	·05	·005
Organic ammonia ...	·038	·044	·05	·04	·055	·055

Remarks.—1. Good for drinking and domestic use. The Free Ammonia varies considerably at times and is not of much importance. The slight differences between the results in 1892 and 1895 are due, no doubt, to the altered and increased supply of water (from some unknown cause) at the well. The Report notes the deterioration between the two dates.

2 and 3. Good for drinking but rather hard for domestic purposes. The Report says elsewhere that 2 is apparently liable to pollution before reaching its service-reservoir; there is (or was, 1896) a farmyard, largely undrained, on adjacent and higher ground, and garden-refuse was piled against the walls of the collecting-reservoir. See also remarks in succeeding analysis.

By [Sir] E Frankland. In August, 1898. Dr. R. J. Reece's Report to the Local Government Board, 1896.

Chelmsford, cont.

In parts per 100,000

	1 Burgess Well Springs.	2 Admiral's Park Springs.	3 Harrington's Market Garden Springs.	4 Deep Well, Mildmay Road.
Total solid matters	46·16	43·4	47·48	103·8
Organic carbon	·066	·051	·058	·117
„ nitrogen	·01	·013	·013	·013
Ammonia	0	·002	0	0
Nitrogen as nitrates and nitrites ...	·767	·048	·746	·038
Total combined nitrogen	·777	·473	·759	·051
Chlorine	2·7	2·8	2·8	32
Hardness : Temporary	23·4	23·2	23·6	1·4
Permanent	4·7	4·3	5·4	0
Total	28·1	27·5	29·5	1·4
	Turbid.	Slightly turbid.	Slightly turbid.	Slightly turbid.

4. Contained 40 grains per gallon of Carbonate of Soda.

1 and 3 are practically identical. They are of very high organic purity, but are derived in part from impure sources and are consequently suspicious and not to be recommended for dietetic use unless they come from deep wells (100 ft. or more). The same applies to 2, except that it contains a much smaller proportion of water from impure sources, and is so less under suspicion.

4. Organically less pure than the others, but shows no evidence of previous sewage or animal contamination, and is on that account the best of the four for domestic supply, in spite of the high saline content. It is almost as soft as distilled water.

All four would require filtration on account of their turbidity.

A later analysis of 2 differs somewhat, see p. 347.

A.—Moulsham. Mildmay Road. Double bore-hole (from a well), one 360 ft., the other 568 ft. deep. Identical waters from both. Jan., 1898. See p. 116.

B.—Moulsham. New well (1901) 662 ft. deep (into Chalk). September. 1901. See p. 117.

By Dr. J. C. Thresh.

	A	B
Ca.	·6	·7
Mg.	·5	·4
Na.	39·5	41·05
CO_3	20·6	21·5
SO_4	8·4	6·8
Cl.	32·8	35·4
NO_3	·08	·15

In parts per 100,000

Probably combined as :—	A	B
Calcium carbonate	1·5	1·75
Magnesium carbonate ...	1·75	1·4
Sodium carbonate	32·6	34·25
Sodium sulphate	12·45	10·05
Sodium chloride	54·1	58·4
Sodium nitrate	—	·65
Etc.	—	
Total solid constituents dried at 180° C. ...	102	106·5
Hardness : Temporary	3°	3·5
Permanent	·5°	0°
Total	3·5°	3·5°
Free ammonia	·08	·084
Organic ammonia	·003	·002
Oxygen absorbed in 15 minutes at 100° C.	·184	—
Oxygen absorbed in 3 hours at 37° C. ...	—	·024
Nitrites	Very faint trace.	nil

A.—No turbidity. Clear and colourless. *B.*—Contained a little fine sand.

Chelmsford, cont.

Chelmsford Waterworks. Galleywood trial-boring. 1912. See pp. 117, 118.

A.—Sample taken on second day of trial-pumping. 1st July, 1912.
B.—Sample taken at conclusion of 14 days' trial-pumping. 12th July, 1912.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	·8	·75	Calcium carbonate	2·	1·85
Mg.	·5	·35	Magnesium carbonate ...	1·75	1·2
Na.	40·49	38·37	Sodium carbonate	31·4	31·75
CO_3	20·2	20·	Sodium sulphate	14·2	13·05
SO_4	9·6	8·8	Sodium chloride	54·8	51·8
Cl.	32·6	31·4	Sodium nitrate	·85	·35
NO_3	·06	·05	Silica, etc.		
			Total solid constituents dried at 180° C. ...	105	100
			Hardness : Temporary	4°	—
			Permanent	0	—
			Total	4°	4°
			Free ammonia	·065	·08
			Organic ammonia	·002	·003
			Oxygen absorbed in 3 hours at 37° C.	·16	·088
			Nitrites	nil	nil

A.—Turbid. Sand deposited and a little Chalk in suspension. Greyish. No odour. Reaction alkaline.

B.—Turbid, fine clay and sand in suspension. Greyish. No odour. Reaction alkaline.

2. From other Chelmsford wells.

A.—Wells and Perry's Brewery. Jan., 1898. See p. 115.

B.—Marconi's Works (450 ft. deep). 17th May, 1912 See p. 114.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	·15	·9	Calcium carbonate	·35	2·25
Mg.	·1	·5	Magnesium carbonate ...	·35	1·73
Na.	42·5	42·14	Sodium carbonate	35·85	33·47
CO_3	20·7	21·5	Sodium sulphate	13·6	10·07
SO_4	9·2	6·8	Sodium chloride	56·6	61·68
Cl.	34·34	37·4	Sodium nitrate	0	·14
NO_3	0	·1	Silica, etc.	·75	·66
			Total solid constituents dried at 180° C. ...	107·5	110·
			Hardness : Temporary	—	4°
			Permanent	—	0
			Total	2°	4°
			Free ammonia	·08	·075
			Organic ammonia	·004	·0015
			Oxygen absorbed in 3 hours at 37° C.	·052	·032
			Nitrites	nil	nil

B.—Clear. Slight deposit of Chalk. Faintly greyish. No odour.

Chingford.

Well of the East London Water Co. (now Metropolitan Water Board). 1885.
See p. 119.

By Dr. J. C. THRESH. 10th July, 1899.

In parts per 100,000

Ca.	6·4	Probably combined as :—	
Mg.	1·6	Calcium carbonate	16·
Na.	1·4	Magnesium carbonate	3·1
CO_3	11·[illegible]	Magnesium sulphate	3·5
SO_4	2·9	Sodium chloride	3·6
Cl.	2·2	Nitrates, ammonia, silica, etc.	·8
NO_3	·08		
		Total solid constituents dried at 180° C....	27

Hardness: Temporary, 17°; Permanent, 5·5°; Total, 22·5°.

Free ammonia	·016
Organic ammonia	0
Nitrites	nil.

Another analysis from Dr. HOUSTON's Report to the Metropolitan Water Board for 1910, p. 51. 10th November, 1909.

In parts per 100,000.

Calcium carbonate	17·57
Magnesium carbonate	2·72
Sodium carbonate	0
Magnesium sulphate	3·79
Sodium sulphate	3·46
Sodium chloride (with a little K Cl.) ...	3·28
Sodium nitrate	0
Sesquioxide of iron and alumina ...	·08
Silica	1·78
Difference	—·16
Total solids	32·52

Hardness:	Temporary	12·9
	Permanent	9·14
	Total	22·04

Chlorine	1·98
SO_4 (calculated from SO_3)	5·36
Calcium (calculated from Ca. O) ...	7·07
Magnesium (calculated from Mg. O) ...	1·54

Clacton.

Waterworks. See pp. 120, 121.

A.—Well reaching a little into Chalk. ? March, 1898.

B.—Shallow well in Watson's land (a field behind the water-tower), see p. 122. 11th July, 1899.

By Dr. J. C. THRESH.

Clacton, cont.

	A	B		In parts per 100,000 A	B
Ca.	2·1	4·2	Probably combined as :—		
Mg.	1·2	1·3	Calcium carbonate	5·25	6·5
Na.	39·75	5·8	Calcium sulphate	—	5·4
K	—	2·1	Magnesium carbonate ...	4·2	—
CO_3	18·6	3·9	Magnesium sulphate ...	—	6·5
SO_4	10·9	10·8	Sodium carbonate	22·	—
Cl.	37·4	7·6	Sodium sulphate	16·1	2·7
NO_3	1·9	3·3	Sodium chloride	61·7	12·5
			Sodium nitrate	2·6	—
			Potassium nitrate	—	5·4
			Silica, etc.	2·65	3·

	A	B
Total solid constituents dried at 180° C. ...	114·5	42
Hardness : Temporary	10°	9·5°
Permanent	1°	5·°
Total	11°	14·5°
Free ammonia	·07	·003
Organic ammonia	·007	·009
Oxygen absorbed in 3 hours at 37° C.	·14	·032
Nitrites	nil	nil

A.—No turbidity. *B.*—Very dull.

The following, referring to the time when Clacton-on-Sea had but lately been made into a seaside-resort, and had no public supply, shallow wells (in the gravel) being the source, is from W. G. Wigner's Water Supply of Sea-side Watering Places, 1878, pp. 18–20.

A.—From a well 8 ft. deep, supplying an hotel.

B.—From a private pump, *considered* very good.

	In parts per 100,000. A	B
Total solid matter	69·43	60·
Loss on ignition, after deducting combined CO_2 ...	10·73	13·26
Iron	trace.	heavy trace
Chlorine, calculated as chloride of sodium	15·94	17·84
Hardness before boiling, Clark's scale	12°	10·4°
,, after boiling, Clark's scale	6·8°	8·3°
Nitrogen as ammonia...	·0034	·0063
,, ,, albuminoid ammonia	·0084	0
,, ,, nitrates	1·534	1·645
,, ,, nitrites	·016	·0043
Total nitrogen in the four forms	1·562	1·664
Oxygen absorbed by organic matter	·16	·106

A.—Colour dirty brown. Smell offensive. Full of suspended matter. The microscope showed the presence of particles of decomposed muscular fibre and hairs. Unfit for use.

B.—Microscopic examination more satisfactory. Colour pale blue. Smell and taste fairly satisfactory.

Clavering.

By Dr. J. C. Thresh. 4th December, 1912.

The Bower. Well 75 ft. deep (?65 ft.). See pp. 122, 123.

			In parts per 100,000
Ca.	13·9	Probably combined as :—	
Mg.	·4	Calcium carbonate	30·
Na.	3·13	Calcium sulphate...	4·25
CO_3	18·	Calcium chloride	1·8
SO_4	3·	Magnesium chloride	1·56
Cl.	3·6	Sodium chloride	3·27
NO_3	3·1	Sodium nitrate	4·25
		Silica, etc.	1·87
		Total solid constituents dried at 180° C. ...	47·

Hardness: Temporary, 28°; Permanent, 8°; Total, 36°.

Free ammonia	0
Organic ammonia	·002
Oxygen absorbed in 3 hours at 37° C. ...	·02
Nitrites	nil

Clear and bright. No deposit. Faintly yellow. No odour. Reaction neutral.

Coggeshall (Great and Little).

A.—Boring (of 1908) for supply of Coggeshall. Braintree Rural District Council (420 or 422 ft. deep). See pp. 123, 124. November, 1908.
B.—Same from a house-tap. 20th April, 1912. The change since *A* of 1908 is noticeable.
C.—Messrs. Swinbourne's (260 ft. deep). See pp. 124, 125. October, 1909.
D.—King's (Gravel End) Brewery. Well 305 ft. deep, 226 to Chalk. See p. 124. July, 1907.
E.—King's Brewery, Well 337 ft. deep. See p. 124. 2nd June, 1899.
F.—Little Coggeshall Brewery (Gardner's). 305 ft. deep. See p. 213. July, 1907.

By Dr. J. C. Thresh.

	A	B	C	D	E	F
Ca.	2·2	2·2	5·5	4·5	4·2	4·5
Mg.	1·55	1·6	2·2	1·45	2·4	·5
Na.	46·4	43·8	18·	22·25	19·6	22·75
Fe.	—	—	—	·3	—	nil
CO_3	20·5	20·	19·5	19·8	19·8	19·7
SO_4	8·7	8·5	6·8	5·65	6·7	6·8
Cl.	49·1	45·7	15·6	19·1	16·5	17·25
NO_3	·1	·3	·3	·25	1·3	·3

In parts per 100,000

Probably combined as :—	A	B	C	D	E	F
Calcium carbonate ...	5·5	5·5	13·7	11·25	10·5	11·25
Magnesium carbonate...	5·45	5·5	7·6	5·05	8·4	1·75
Sodium carbonate ...	23·55	22·7	10·4	16·2	12·7	20·7
Ferrous carbonate ...	—	—	—	·6	—	—
Sodium sulphate ...	12·9	12·6	10·1	8·35	9·9	9·25
Sodium chloride ...	81·	75·4	25·7	31·5	27·2	28·45
Sodium nitrate ...	·15	·4	·4	·35	1·8	·4
Silica, &c.	·95	2·9	2·1	1·3	—	1·2
Total solid constituents dried at 180° C. ...	129·5	125·	70·	74·6	70·5	73.
Hardness : Temporary ...	8°	—	—	—	12·5°	—
Permanent ...	4°	—	—	—	4·5°	—
Total	12°	12°	23°	14°	17°	12°
Free ammonia	·1	·02	·093	·016	·048	·04
Organic ammonia	·004	·001	·001	·002	·003	·000
Oxygen absorbed in 3 hours at 37° C. ...	·028	·036	·0036	—	·016	·000
Nitrites	nil	trace	nil	nil	nil	trace

B.—Clear and bright. Good appearance. No deposit. Very faint yellow. No odour. Reaction neutral.
E.—Tested for potassium with negative result. Water clear at first. Became cloudy on standing. Had a faint peculiar odour, due to action of water on coating of mains.

Colchester.

1. Well at waterworks. From the *Sixth Rep. Riv. Poll. Comm.*, 1874, p. 106.

Depth of well given as 400 ft. [?]. See pp. 129, 130. 2nd April, 1873.

	In parts per 100,000
Temperature centigrade, 11·4°.	
Total solid impurity	96·2
Organic carbon	·174
Organic nitrogen	·03
Ammonia	·021
Nitrogen as nitrates and nitrates	2·582
Total combined nitrogen	2·629
*Previous sewage or animal contamination ...	25,670
Chlorine	21·
Hardness:—Temporary, 12·7; Permanent, 13·; Total, 25·7.	

Clear and palatable.

From Chalk under London Clay. One of several polluted deep well waters. Contains organic elements in such proportions as to lead to the conclusion that organic matter was present without having undergone the purification resulting from its passage through a thick stratum of porous and aerated rock. Where the previous sewage contamination figure is under 20,000 it is said in the general remarks that matters may very probably be remedied by attention to the upper part of the well and to its immediate surroundings. Here the figure is 25,670.

Cannot be considered free from suspicion.

* For explanation, see **Colchester,** p. 348.

Waterworks (Chalk-supply).

Three analyses: —*A*, by W. Foster, 1st April, 1889; *B*. by W. Chattaway, 27th December, 1894; *C*, by Dr. J. C. Thresh, 24th February, 1898.

	In parts per 100,000 A	B	C
Total solids	102·86	98·71	93 (Dried at 180° C.)
Volatile solids	—	7·71	—
Fixed solids	—	91·	—
Chlorine	30·44	30·	—
Free ammonia	·0814	·0721	·08
Organic ammonia	·0086	·0061	·006
Oxygen absorbed from acid permanganate when—			
(*a*) Boiled for 15 minutes ...	—	—	·14
(*b*) Digested for 4 hours at 80° F.	—	—	·052
Nitrates	—	trace.	Nitric Nitrogen ·01
Nitrites	none	none	none
Phosphates	mere trace	—	none
Lead salts	none	—	—
Hardness. Total ...	—	12°	14·
Calcium carbonate	—	—	6·57
Magnesium carbonate	—	—	6·
Sodium carbonate	—	—	16·86
Sodium chloride	—	—	52·33
Sodium sulphate	—	—	10·71
Traces of ammonia, nitrates, iron, &c.	—	—	·53

Colchester, cont.

A.—Waterworks. Artesian well (sunk 1881), just outside Roman Wall. See p. 130. 11th February, 1898.

B.—Same. 11th November, 1911.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as —	A	B
Ca.	2·7	2·9	Calcium carbonate	6·75	7·3
Mg.	1·7	1·3	Magnesium carbonate ...	5·95	4·5
Na.	31·3	31·15	Sodium carbonate	16·8	17·9
CO_5	17·8	17·7	Sodium sulphate	11·1	8·9
NH_4	·08	—	Sodium chloride	51·8	51·5
SO_4	7·5	6·	Sodium nitrate	—	·5
Cl.	31·4	31·1	Silica, &c.	·6	1·4
NO_3	·04	·35			
			Total solid constituents dried at 180° C. ...	93·	92·
			Hardness Temporary	12°	—
			Permanent	4°	—
			Total	16°	12°
			Free ammonia	·07	·06
			Organic ammonia	·006	·003
			Oxygen absorbed in 3 hours at 37° C. ...	·052	·04
			Nitrites	nil	nil

A.—No turbidity. Clear, bright. Bluish green.

B.—Clear, bright. Very faint yellow. No odour. Reaction neutral.

Colchester, cont.

2. Various Colchester Wells.

A.—Mile End. New Essex County Asylum. See p. 128. 7th December, 1908. *B.*—Same. 11th August, 1912. *C.*—Well at gasworks (250 ft. deep). See p. 128. March, 1898. *D.*—Parry's Oil Mills (sunk 1884, 200 ft. deep). See p. 128. March, 1898. *E.*—Eagle Brewery (sunk 1877, 400 ft. deep. See pp. 126, 127. March, 1898. *F.*—East Hill Brewery (sunk 1888, 250 ft. deep). See p. 127. 8th April, 1899. *G.*—Colchester sewage-works. Sewage Farm (218 ft. deep). See pp. 128, 129. April, 1899.

By Dr. J. C. Thresh.

	A	B	C	D	E	F	G
Ca.	1·9	1·9	2·65	2·	1·8	2·1	1·95
Mg.	1·15	1·6	1·1	2·2	3·7	2·	2·1
Na.	52·7	54·06	38·45	40·	31·6	31·7	33·35
NH_4	—	—	·09	·1	·1	·08	—
CO_3	18·9	18·7	19·2	19·4	17·7	17·9	18·3
SO_4	8·6	9·6	6·7	10·	6·8	6·7	6·5
Cl.	59·	62·	39·6	41·3	36·5	32·4	34·6
NO_3	·35	·12	·07	·12	·43	·06	·06

In parts per 100,000

Probably combined as :—	A	B	C	D	E	F	G
Calcium carbonate	4·75	4·75	6·6	5·	4·5	5·25	4·9
Magnesium carbonate ...	4·	5·54	3·85	7·7	12·95	7·	7·35
Sodium carbonate	23·3	21·07	22·	19·25	10·15	17·2	17·85
Sodium sulphate	12·7	14·21	9·9	14·8	10·05	9·9	9·6
Sodium chloride	97·35	102·25	65·35	68·15	60·2	53·45	57·1
Sodium nitrate	·5	·16	—	—	·7	—	—
Silica, &c.	2·4	·02	4·3	·6	·45	1·2	1·2
Total solid constituents dried at 180° C....	145	148	112	115·5	99	94	98
Hardness: Temporary ...	7°	8°	7°	12°	12°	7°	—
Permanent ...	4°	3°	6°	3°	8°	4°	—
Total	11°	11°	13°	15°	20°	11°	—
Free ammonia	·088	·104	·08	·09	·09	·000	·09
Organic ammonia	·003	·004	·002	·006	·001	·003	·003
Oxygen absorbed in 3 hours at 37° C. ...	·062	·008	·024	·036	·02	·044	·008
Nitrites	nil	nil	nil	nil	nil	nil	nil

B.—Clear, of good appearance, no deposit. Very faint yellow. No odour.
G.—No turbidity. Clear and colourless.

Corringham.

Thames Haven. Thames Haven Co., Ltd. Boring begun in 1877. See pp. 132–134.

A series of analyses of the water found at various depths during construction.

A.—At $78\frac{1}{4}$ ft. down. Before touching the clay.

B.—From $118\frac{1}{2}$ to $122\frac{1}{2}$ ft. down. (*A* excluded wholly or partially.)

C.—From flint-veins at 360 ft. (*A* and *B* excluded by tubing.)

D.—From 460 and 502 ft. (*A* and *B* excluded as in *C.*)

E.—572 ft., the bottom. (*A* and *B* excluded.)

In parts per 100,000.

	A	B	C	D	E
Total solid matter ...	4417·3	687·6	61·43	61·14	64
Volatile organic matter ...	475·7	95·14	2·79	·07	·71
Chloride of sodium ...	1700·	496·6	24·74	24·91	25·4
Nitrogen as ammonia ...	6·4	5·	·143	·055	·009
Nitrogen as albuminoid ammonia...	4·43	·3	·0106	·0066	0
Calcium sulphate	—	—	4·29	3·57	0
Calcium carbonate ...	—	—	8·29	8·29	5
Hardness. Clark's scale —					
Before boiling	—	—	—	—	7·8°
After boiling	—	—	—	—	4·6°

Final analysis by G. W. Wigner. 18th June, 1879. Two hours after commencing pumping (? *i.e.*, after completion of well). In parts per 100,000.

Total solid matter	62·51	Mineral matter probably combined as —	
Total mineral matter ...	61·26		
Loss on ignition... ...	1·25	Calcium sulphate... ...	6·4
Chlorine as chloride of sodium	23·4	Magnesium sulphate ...	7·6
Lead and Copper	none	Potassium carbonate ...	11·4
Iron	traces	Sodium carbonate ...	8·6
Lime	2·63	Sodium chloride	23·4
Magnesia	2·54	[Silica, etc.]	3·9
Alkaline salts as carbonates...	12·86		61·3
Sulphuric acid in combination	8·81		
Phosphoric acid	traces		
Nitrogen as ammonia ...	·1		
Nitrogen as albuminoid ammonia	0		
Nitrates and Nitrites ...	traces only.		
Oxygen absorbed by organic matter from solution of permanganate of potash ...	0		

Colour of water in 2-ft. tube, very good, pale blue. Suspended matter, none. Smell at 100° F., none. Taste, very slightly saline.

Hardness, before boiling, 9·3°; after boiling, 5·7° (Clark's scale).

Appearance of dried residue, white, semi-crystalline.

Microscopical results quite satisfactory, no living organisms detected.

Dissolved gases. Carbonic acid gas, none. Oxygen, ·25 cubic in. per gallon. Nitrogen, 2· cubic in. per gallon.

The valuation of the water by Wigner's scale (taking the average value of London water as about 25 and the best public supplies at 10 to 15) is 21, after making suitable allowance for the source from which the salt (sodium chloride) is derived. Therefore a first-class water.

The results indicate great organic purity. Only 1·26 parts per 100,000 (of the solid residue) is driven off on ignition, and of this ·97 is combined water. Actual volatile organic matter therefore only ·29 parts per 100,000.

Corringham, cont.

The only objection is the proportion of sodium chloride (salt), but it is clear from the (low) figures of combined nitrogen that it is not derived from organic sources and so its presence is of far less moment.

Well fitted for drinking purposes.

[The water above the clay was very salt (? infiltration from the river). The final water was an alkaline water from the Chalk. Yet the Chalk-water, completely different as it was, rose and fell with the tide.]

Dagenham.

Water from No. 1 or East well, supplying Messrs. Samuel Williams. See p. 136. By Dr. J. C. Thresh. Sept. 5, 1911.

In parts per 100,000

		Probably combined as —	
Ca.	4·1	Calcium carbonate ...	10·25
Mg.	2·	Magnesium carbonate ...	6·92
Na.	10·07	Sodium carbonate ...	9·25
CO_3	16·3	Sodium sulphate	7·25
SO_4	4·9	Sodium chloride	9·4
Cl.	5·7	Silica, &c.	·43
NO_3	0		

Total solid constituents dried at 180° C. 43·5

Hardness: Temporary, 10°; Permanent, 8°; Total, 18°

Free ammonia	·065
Organic ammonia	·000
Oxygen absorbed in 3 hours at 37° C. ...	·036
Nitrites...	nil

Dagenham Dock. Union Cable Co. 200 ft. boring, in Chalk. July, 1912. By Dr. J. C. Thresh.

In parts per 100,000

		Probably combined as —	
Ca.	3·8	Calcium carbonate ...	9·5
Mg.	1·8	Magnesium carbonate ...	6·25
Na.	10·8	Sodium carbonate ...	11·05
CO_3	16·4	Sodium sulphate ...	6·2
SO_4	4·2	Sodium chloride	9·9
Cl.	6·	Sodium nitrate	·35
NO_3	·25	Silica, &c.	·75

Total solid constituents dried at 180° C.... ... 44

Hardness: Temporary, 16·5°; Permanent, 1·5°; Total, 18°.

Free ammonia	·02
Organic ammonia	·006
Oxygen absorbed in 3 hours at 37° C. ...	·064
Nitrites	nil

Dull. Faint yellow tint. No odour.

Dedham.

Analyses by Dr. J. C. Thresh.

A.—Lower Park House. Shallow well, see p. 138. April, 1898.
B.—Grammar school. Public pump in street, see p. 138. June, 1898.
C.—Same as *B*, 5th March, 1912.
D.—Tendring Hundred Water Co. New bore (1912), see p. 138. 5th February, 1912.
E.—Tendring Hundred Water Co. New bore (1912). 14th February, 1912.

Dedham, *cont.*

	A	B	C	D	E
Ca.	13·5	6·8	6·8	7·	7·1
Mg.	1·3	2·6	3·	3·3	3·1
Na.	6·9	12·3	10·75	20·1	19·99
Fe.	—	·3	trace.	—	—
CO_3	16·8	17·	17·2	18·3	17·5
SO_4	9·4	6·8	4·8	6·	6·8
Cl.	11·5	13·9	13·6	27·2	26·7
NO_3	·15	0	·13	0	0

B.—Goes slightly turbid from deposition of iron.

C.—When unfiltered it contained ·7 parts per 100,000 of iron.

In parts per 100,000	A	B	C	D	E
Probably combined as:—					
Calcium carbonate	28·	17·	17·	17·5	17·75
Calcium sulphate	7·8	—	—	—	—
Magnesium carbonate	—	9·1	9·8	10·9	9·63
Magnesium sulphate	4·9	—	1·	1·	1·58
Magnesium chloride	1·2	—	—	—	—
Ferrous carbonate	—	·6	—	—	—
Sodium sulphate	—	10·1	5·9	7·7	8·2
Sodium chloride	17·5	22·9	22·4	44·8	44·03
Sodium nitrate	—	—	·2	—	—
Silica, alumina, &c., including nitrates if not otherwise given...	·6	1·8	·7	·6	·31
Total solid constituents dried at 180° C. ...	60·	61·5	57·	82·5	81·5
Hardness: Temporary	21°	—	—	25°	25°
Permanent	16°	—	—	8°	7°
Total	37°	31°	32°	33°	32°
Free ammonia	·011	0	·051	·055	·056
Organic ammonia	·009	·004	·001	·003	·003
Oxygen absorbed in 3 hours at 37° C. ...	—	·04	·016	·02	·028
Nitrites	nil	nil	nil	nil	very small trace.
Turbidity	—	—	Turbid, clayey and irony.	Clear. Good appearance. No deposit.	Clear. Good appearance. No deposit.
Colour	—	—	Yellowish grey.	Slightly greyish.	—
Odour	—	—	none.	none.	—
Reaction	—	—	neutral.	—	—

Dovercourt.

By Dr. J. C. Thresh. 20th December, 1901.

Waterworks. Taken over by Tendring Hundred Water Co. and abandoned. See p. 139.

In parts per 100,000

		Probably combined as —	
Ca.	11·2		
Mg.	3·2	Calcium carbonate	28·
Na.	42·3	Magnesium carbonate...	3·1
CO_3	19·	Magnesium sulphate ...	11·5
SO_4	11·5	Sodium sulphate	3·4
Cl.	63·4	Sodium chloride ...	104·6
NO_3	·09	Etc.	·4
		Total solid constituents dried at 180° C.	151

Hardness: Temporary, 33°; Permanent, 11°; Total, 44°

Free ammonia	·1
Organic ammonia	·002
Oxygen absorbed in 3 hours at 37° C. ...	·016
Nitrites	nil.

Entered as Harwich in the *Rep. Riv. Poll. Comm.*

Bole-hole intended for town-supply. From the *Sixth Rep. River Poll. Comm.*, 1874, p. 106. 24th October, 1873.

Said to be 380 ft. deep. (? This is probably the Dovercourt well. See p. 139.)

In parts per 100,000

Total solid impurity	216·4
Organic carbon	·144
Organic nitrogen	·081
Ammonia	·15
Nitrogen as nitrates and nitrites	0
Total combined nitrogen	·204
*Previous sewage or animal contamination	910
Chlorine	106·

Hardness: Temporary, 16·4; Permanent, 34·3; Total, 50·7
Slightly turbid; palatable.

* For explanation of previous sewage contamination, see **Colchester,** p. 348.

One of several *polluted* deep well waters. Could not be considered free from suspicion. Contains organic elements in such proportions as to lead to the conclusion that organic matter was gaining access to the water without having undergone that purification resulting from its passage through a thick stratum of porous and aerated rock. In this sample the low figure for previous sewage pollution suggests that the evil might be remedied by attention to the upper part of the well and its immediate surroundings.

See also **Harwich.**

Downham.

Southend Water Co.'s well of 1909.

A.—18th August, 1909 (before being brought into use).

B.—25th June, 1910.

By Dr. J. C. Thresh.

Downham, cont.

In parts per 100,000

	A	B	Probably combined as —	A	B
Ca.	·75	·97	Calcium carbonate ...	1·85	2·42
Mg.	·25	·25	Magnesium carbonate...	·9	·86
Na.	36·75	35·46	Sodium carbonate ...	32·45	31·74
CO_3	20·1	20·	Sodium sulphate ...	17·	13·
SO_4	11·5	8·8	Sodium chloride ...	43·55	44·2
Cl.	26·4	26·8	Sodium nitrate ...	0	·24
NO_3	0	·18	Silica, &c.	1·25	·54
			Total solid constituents dried at 180° C. ...	97	93
			Hardness · Total...	3°	3·5°
			Free ammonia	·01	·053
			Organic ammonia...	·004	·002
			Oxygen absorbed in 3 hours at 37° C. ...	·16	·044
			Nitrites	nil	nil

B.—Very clear. Very faint yellow. No odour.

Earl's Colne.

Ironworks (well 350 ft. deep), see p. 141. More fully in Addenda.
By Dr. J. C. Thresh (about 1900 or earlier). From his Report of 1901, p. 38.

In parts per 100,000.

Calcium carbonate	...	8·71
Magnesium carbonate	...	9·57
Sodium sulphate	...	11·57
Sodium chloride...	...	35·43
Nitrates, silica, &c.	...	1·71
Total solids	...	66·99

East Ham.

Water from a deep trench for a sewer near sewage-works. For the Urban District Council.

A few feet above Ordnance Datum. In alluvium.
By Dr. J. C. Thresh. 24th February, 1912.

In parts per 100,000

		Probably combined as —	
Ca.	35·4 ...	Calcium carbonate	70·
Mg.	11· ...	Calcium sulphate...	25·2
Na.	61·7 ...	Magnesium sulphate	26·5
Fe.	Deposit of Fe_2O_3...	Magnesium chloride	22·7
CO_3	42· ...	Sodium chloride	156·7
SO_4	39· ...	Organic matter, water of hydration, &c.	24·9
Cl.	112· ...		
		Total solid constituents dried at 180° C.	About 326

Hardness Total...	...	150°
Free ammonia ...	...	loaded.
Organic ammonia	...	Excessive.
Nitrites	...	nil.

Reddish yellow (with $FeCO_3$). Colour earthy. Odour earthy. Reaction neutral. Obviously the subsoil contains some tidal water.

Various wells in East Ham.

A.—Messrs. Burgoyne and Burbidges, High Street South. See p. 144.
B.—Beckton. Gas Light and Coke Co. Artesian well. 14th October, 1907.
C.—Beckton. Gas Light and Coke Co. Artesian well. See p. 144. 14th July, 1909.
D.—Beckton. Gas Light and Coke Co.'s Tar and Liquor Works. Artesian well No. 4. See p. 144. 16th July, 1909.
E.—East Ham Electric Light Works. See p. 144. 11th October, 1902.
F.—East Ham Electric Light Works. 21st July, 1909.

By Dr. J. C. Thresh.

East Ham, cont.

In parts per 100,000

	A	B	C	D	E	F
Ca.	15·1	5·4	5·2	4·7	5·	4·7
Mg.	3·1	1·6	1·9	1·7	2·5	1·8
Na.	25·86	8·7	10·1	7·6	5·6	6·1
K.	—	trace.	—	—	trace.	—
CO_3	15·3	14·6	15·1	14·	14·3	14·2
SO_4	17·6	3·7	3·7	4·	4·4	3·7
Cl.	44·	7·6	8·8	5·	4·	3·
NO_3	·7	·15	1·4	·8	·4	·5
Iron	trace (in suspension)					

Probably combined as :—	A	B	C	D	E	F
Calcium carbonate ...	25·5	13·5	13·	11·7	12·5	11·7
Calcium sulphate ...	16·6	—	—	—	—	—
Magnesium sulphate ...	7·4	—	—	—	—	—
Magnesium carbonate	—	5·6	6·6	5·8	8·75	6·2
Magnesium chloride ...	6·2	—	—	—	—	—
Sodium carbonate ...	—	4·5	4·6	5·	1·05	4·9
Sodium sulphate ...	—	5·45	5·5	5·9	6·5	5·5
Sodium chloride ...	65·	12·55	14·6	8·3	6·6	5·
Sodium nitrate ...	·9	—	1·9	1·1	—	·7
Potassium nitrate ...	—	·25	—	—	1·3	—
Silica, &c.	2·6	1·65	·3	·3	·3	·3
Total solid constituents dried at 180° C.	124·2	43·5	46·5	38·1	37·	34·3
Hardness : Temporary ...	22°	14°	12°	12°	18·5°	19
Permanent ...	32°	7°	9°	8°	1·5°	1
Total	54°	21°	21°	20°	20°	20
Free ammonia	·0078	·0406	·0024	·0016	·036	·055
Organic ammonia	·0062	·004	·0016	·0022	·004	·002
Oxygen absorbed	·04	·016	·008	·02	·044	·015
Nitrites	nil	nil	nil	nil	nil	nil
Turbidity	Slight opalescence. Reddish sediment containing iron.	—	Very slight flocculent.	None. Clear and bright.	—	Slight white opalescence.
Colour	Slight yellowish green.		Slight greenish.	Slight greenish.		Slight greenish.
Odour	None.		None.	None.		None,

East Mersea.

1. Reeves Hall. See p. 146. 24th July, 1911.

By Dr. J. C. Thresh.

In parts per 100,000

Ca.	1·8	Probably combined as :—	
Mg.	·31	Calcium carbonate ...	4·5
Na.	72·7	Magnesium carbonate...	1·07
CO_3	22·6	Sodium carbonate ...	33·84
SO_4	15·6	Sodium sulphate ...	23·1
Cl.	77·6	Sodium chloride ...	128·
NO_3	·37	Sodium nitrate ...	·47
		Silica, &c.	·02

Total solid constituents dried at 180° C. 191·

Hardness: Total ... 7°

Free ammonia	·015
Organic ammonia	·004
Oxygen absorbed in 3 hours at 37° C. ...	·064
Nitrites	trace

2. Deep well to Chalk, see pp. 145, 146.

By Prof. J. Attfield. June, 1883. In parts per 100,000.

Total solid matter dried at 212° F.	182·86
Nitrogen in Nitrates (= Nitrates ·57)... ...	·1
Chlorine as Chlorides	70·
Free ammonia	·07
Albuminoid ammonia	·007

Hardness: Temporary, 10°; Permanent, 1°; Total, 11°.

Free from any serious contamination by animal or vegetable matter. Contains a good deal of salt; indeed, appears to contain some sea-water.

It is difficult to say how much salt is enough to make drinking-water injurious. There is no more salt in a gallon of this water than a person would commonly take at dinner.

Eastwood.

1. Eastwood Pumping Station of the Southend Water Co. See pp. 146, 147.

By Dr. C. M. Tidy, in December, 1891. Appendix to Dr. R. B. Low's Report to the Local Government Board, No. 105, 1896.

	In parts per 100,000
Total solid matter	93·43
Ammonia	·013
Nitrogen in nitrates and nitrites (= Nitric acid ·611)	·134
Oxygen required to oxidize organic matter	·048
Lime (Ca. O)	·96
Magnesia (Mg. O)	traces
Sulphuric anhydride (SO_3)	3·9
Chlorine (= common salt 46·19)	28·18
Organic carbon	·078
,, nitrogen	·018

Hardness before boiling 2·92°; after boiling ·5°

Clear and bright. Reaction alkaline. An excellent water. Contains very little organic matter. Very soft. A good wholesome water for a public supply.

Corresponds closely with Dr. Thresh's analyses, which follows.

Other analyses are of water from reservoir and from taps and refer to the *general* supply (not Eastwood).

Eastwood, cont.

From Dr. J. C. THRESH'S Report to the Local Board on Typhoid at Southend. 1890.

By Dr. THRESH. October, 1890.

Clear and colourless.

	In parts per 100,000
Total solids	94·29
Effect of ignition ...	nil.
Phosphates	nil
Nitric nitrogen	·114
Chlorine	27·57
Alkalinity	28·14
Hardness	3·57
Lead and Iron	none
Free ammonia	·066
Organic ammonia ...	·002
Nitrous nitrogen	0
Oxygen used in 3 hours	·017

Microscopic Examination.—No vegetable or animal life; no signs of pollution.

He states in the Report that he could find no reason to attribute the Typhoid to the water-supply.

2. From the Oakwood well of the Southend Water Co. See p. 148.

By F. SUTTON, 1894. Appendix to Dr. R. B. Low's 'Report to the Local Government Board, No. 105, 1896.

	In parts per 100,000
Ammonia, free	·015
Organic ammonia	none
Chlorine	31·6
Nitrogen as nitrates or nitrites	none
Oxygen required (to oxidize organic matter) ...	·049
Lime	1·07
Magnesia	1·08
Sulphuric anhydride	5·63
Silica	·76
Oxide of iron and alumina	·18
Total solids in solution	90·86
Hardness before boiling 2·62°; after boiling 1·82°	

Bright, clear and faint greenish. Free from any trace of organic impurity, either in solution or suspension. Of exceptional value for a public supply. Exceptionally soft, from the presence of salts of potash and soda.

Eastwood, cont.

3.—Some of the Eastwood Wells of the Southend Water Company—

A.—Nobles Green Pumping Station. See pp. 147, 148. 28th December, 1908.
B.—Picketts Pumping Station. See p. 149. 25th May, 1910.
C.—Sutton Pumping Station. See p. 149. 11th September, 1911.
D.—Oakwood Pumping Station. See p. 148. 11th March, 1910.
E.—Oakwood Pumping Station. 2nd June, 1910.
F.—Oakwood, from sand. 1st June, 1910.

By Dr. J. C. Thresh.

	A	B	C	D	E	F
Ca.	·75	1·2	·75	·95	·8	1·1
Mg.	·4	·19	·15	·3	·25	·25
Na.	37·55	35·87	38·2	36·65	34·94	36·84
CO_3	16·8	16·6	16·	16·8	17·	17·8
SO_4	6·9	5·6	8·7	7·	5·25	6·7
Cl.	35·2	34·	35·15	34·	32·	33·2
NO_3	·15	·2	·15	·13	·13	·13

In parts per 100,000

Probably combined as :—	A	B	C	D	E	F
Calcium carbonate	1·85	3·	1·85	2·35	2·	2·7
Magnesium carbonate	1·4	·65	·55	1·	·86	·86
Sodium carbonate	26·	25·34	25·65	26·	26·99	27·59
Sodium sulphate	10·2	8·3	12·85	10·3	7·75	9·9
Sodium chloride	58·1	56·1	58·	56·	52·7	54·8
Sodium nitrate	·2	·27	·2	·18	·17	·17
Silica, &c. (some sandy clay in C.)...	1·25	1·34	3·7	·17	·53	·98
Total solid constituents dried at 180° C....	99·	95·	102·8	96·	91·	97·
Hardness : Temporary (per 100,000)	—	—	2·5°	—	—	—
Permanent (per 100,000)	—	—	·5°	—	—	—
Total (per 100,000)	4°	3·2°	3°	2·8°	3°	5°
Free ammonia	·052	·088	·128	·042	·042	·086
Organic ammonia	·002	·003	·006	·002	·002	·002
*Oxygen absorbed in 3 hours at 37° C.	·036	·15	·05	·03	·022	·031
Nitrites	small trace.	nil	nil	very minute trace.	nil	nil

* A in 4 hours at 27° C.

B.—Turbid. Grey. Slight odour.

C.—No free carbonic acid gas (CO_2). Trace of vegetable debris. Turbid with clayey sand which did not filter out.

D, E and *F.*—Very clear. Very slight yellow. No odour.

Epping.

1. From an artesian well. From the *Sixth Rep. Riv. Poll. Comm.*, 1874, p. 103 (repeated p. 295).

10th July, 1872.	In parts per 100,000
Total solid impurity	64·88
Organic carbon	·088
Organic nitrogen	·005
Ammonia	·05
Nitrogen as nitrates and nitrites	·084
Total combined nitrogen	·13
*Previous sewage or animal contamination ...	930
Chlorine	6·2

Hardness: Temporary, 0; Permanent, ·9; Total, ·9

Slightly turbid; palatable.

* For explanation of previous sewage contamination, see **Colchester,** p. 348.

Organically the water is favourably spoken of.

One of 13 samples of water from deep wells in the Chalk beneath London Clay. The high total solids (generally largely Sodium Chloride and often also Sodium Bicarbonate) are remarked on but are stated to be harmless if not in excessive quantity, 100 parts per 100,000 being considered excessive; the average total solids for these 13 samples being 78·09 per 100,000.

2. Various Epping well-waters. By Dr. J. C. Thresh.

A.—Epping Workhouse. (Shallow well.) April, 1907.

B.—Old Bank. (Well about 200 ft. deep.) 7th November, 1909.

C.—Epping Sanitary Steam Laundry Co. (Well about 800 ft. deep.) Near Epping railway-station. See pp. 152, 153. 7th November, 1909.

In parts per 100,000

	A	B	C	Probably combined as :—	A	B	C
Ca.	10·	19·9	3·75				
Mg.	1·1	5·	1·3	Calcium carbonate ..	15·5	38·5	9·35
Na.	2·55	22·1	22·85	Calcium sulphate ...	12·95	15·3	—
CO_3	9·3	23·1	18·3	Magnesium carbonate	—	—	4·55
SO_4	9·15	48·	21·6	Magnesium sulphate	—	24·7	—
Cl.	3·8	21·	7·4	Magnesium chloride	4·2	—	—
NO_3	5·4	·5	1·2	Sodium carbonate ..	—	—	16·7
				Sodium chloride ...	1·15	34·6	12·2
				Sodium sulphate ...	—	25·8	31·9
				Sodium nitrate ...	7·5	·7	1·65
				Etc.	·7	2·9	·65
Total solid constituents dried at 180° C. ...					42·	142·5	77·
Hardness:				Temporary ...	15°	—	—
				Permanent ...	15°	—	—
				Total ...	30°	80°	20°
Free ammonia					·000	·002	·000
Organic ammonia					·004	·005	·006
Oxygen absorbed in 3 hours at 37° C. ...					—	·084	·064
Nitrites					nil	nil	nil

B.—Fairly clear. Faintly yellow. No odour.

C.—Very clear. Faintly yellow. No odour. A little subsoil water gets into this well.

Felsted.

1 Hartford End. South of the village. From the *Sixth Rep. Riv. Poll. Comm.*, 1874, p. 85.

4th March, 1872.	In parts per 100,000
Total solid impurity	84·1
Organic carbon	·149
Organic nitrogen	·012
Ammonia	·001
Nitrogen as nitrates and nitrites	0
Total combined nitrogen	·013
*Previous sewage or animal contamination	0
Chlorine	16·8

Hardness: Temporary, 15; Permanent, 8·9; Total, 23·9.
Slightly turbid; palatable.

*For explanation of previous sewage contamination, see **Colchester**, p. 348.

One of several samples from shallow wells in gravel on London Clay, which though yielding clear and palatable water are horribly polluted, and as a rule with very few exceptions in the series of samples quoted [of which exceptions this is possibly one, as it appears to be one of the best] are supplied by infiltration from sewers and cesspools.

2. The School. Deep well to Chalk. See p. 155.
By Prof. LIVEING (before 1896).

	In parts per 100,000
Calcium carbonate	4·37
Magnesium carbonate	3·15
Sodium carbonate	26·48
Sodium sulphate	14·29
Potassium sulphate	2·56
Sodium chloride	47·45
Mineral constituents, besides traces of Silica... ...	98·37

Hardness: Permanent, 1·6°; Temporary, 3·65°; Total, 5·25°.	
Free ammonia	·079
Albuminoid ammonia	·0017

Another analysis (well 404 ft. deep) by Dr. J. C. THRESH. 10th June, 1898.

10th June 1898.		Probably combined as :—	In parts per 100,000
Ca.	1·4	Calcium carbonate ...	3·5
Mg.	1·	Magnesium carbonate ...	3·5
Na.	36·6	Sodium carbonate ...	26·9
CO_3	19·9	Sodium sulphate	16·
SO_4	10·8	Sodium chloride	40·1
Cl.	24·3	Silica, &c.	·5
NO_3	·2		
Total solid constituents dried at 180° C. ...			90·5

Hardness: Temporary, 6°; Permanent, 1°; Total, 7°.	
Free ammonia	·06
Organic ammonia	·000
Nitrites	minute trace.

Fobbing.

A.—Fobbing Marsh. Slated House. (Well 276 ft. deep. Furlong.) See p. 156. April, 1898.
**B.*—Fobbing Marsh. Kynoch's Works. Borley House. (Well 700 ft. deep, 450 in Chalk.) See p. 134. June, 1898.
C.—Fobbing main well. Southend Water Co. See p. 157. March, 1905.
D.—Fobbing auxiliary well. Southend Water Co. See pp. 157, 158. 3rd August, 1905.

By Dr. J. C. Thresh.

	A	B	C	D
Ca.	·725	1·45	1·5	8·8
Mg.	·25	·75	·25	2·45
Na.	26·9	32·8	26·45	27·85
NH_4	·05	—	—	·112
CO_3	14·7	12·6	15·25	19·2
SO_4	11·7	14·2	12·8	39·5
Cl.	17·5	29·8	16·6	13·7
NO_3	·06	·23	·25	·25

In parts per 100,000

Probably combined as :—	A	B	C	D
Calcium carbonate	1·8	3·6	3·75	22·
Magnesium carbonate	·85	2·65	·9	8·45
Sodium carbonate	22·95	15·05	21·85	0
Sodium sulphate	17·3	21·	18·95	58·45
Sodium chloride	28·5	49·2	27·4	22·6
Sodium nitrate	—	·3	·35	—
Ammonium nitrate	—	—	—	·35
Silica, &c.	1·6	·7	1·8	·65
Total solid constituents dried at 180° C.... ...	73·	92·5	75	112·5
Hardness : Temporary ...	3°	5°	4°	31°
Permanent ...	1°	·5°	1°	1°
Total ...	4°	5·5°	5°	32°
Free ammonia	·05	·06	·08	·1
Organic ammonia	·001	·005	·04	·006
Oxygen absorbed in 3 hours at 37° C.	·06	·06	·111	·089
Nitrites	nil	nil	nil	nil

* This well is in Corringham, not Fobbing.

Foulness.

A.—East Newlands Farm. (Mr. J. Hepburn's.) (412 ft. deep.) See p. 161. 15th July, 1911.
B.—Courtend (or Courtsend). 15th July, 1911.
C.—Churchend Old Hall. (429 ft. deep.) Recently deepened and used for public supply. See p. 161. 15th July, 1911.
D.—Mr. C. Hall (? Churchend Old Hall). (430 ft. deep.) 5th November, 1909.

By Dr. J. C. Thresh.

In parts of 100,000

	A	B	C	D
Ca.	·9	·87	4·1	2·8
Mg.	·28	·28	2·	1·1
Na.	47·33	46·08	68·58	63·5
NH_4	—	—	—	·15
CO_3	19·	19·	19·5	20·
SO_4	8·2	7·3	12·8	11·9
Cl.	46·7	45·5	85·8	73·6
NO_3	·31	·4	·62	—

Probably combined as :—	A	B	C	D
Calcium carbonate	2·25	2·17	10·25	7·
Magnesium carbonate	·97	·97	6·92	3·8
Sodium carbonate	29·98	30·09	14·93	23·2
Sodium sulphate	12·1	10·8	18·95	17·5
Sodium chloride	77·	75·	141·5	121·4
Sodium nitrate	·42	·55	·85	—
Etc.	·28	·42	·6	2·6*
Total solid constituents dried at 180° C....	123·	120·	194·	175·5
Hardness	3·5°	4°	21°	14°
Free ammonia	·001	·04	·0105	·144
Organic ammonia	·002	·002	·003	·002
Oxygen absorbed in 3 hours at 37° C. ...	·04	·064	·04	·044
Nitrites	nil	trace	nil	nil

* Traces of ammonia, organic matter, iron, nitrates, etc. in D.

A.—Dull. Yellowish. No odour.
B.—Dull, very small amount of suspended matter. Slightly yellowish. No odour.
C.—Slightly dull. Slightly yellowish grey. No odour.
D.—Dull (slight chalky deposit). Faint yellow. No odour.

Foxearth.

Foxearth Brewery, see p. 162. By Dr. J. C. THRESH. 11th March, 1909.

In parts per 100,000

		Probably combined as :—	
Ca.	12·4	Calcium carbonate ...	31·
Mg.	1·7	Magnesium sulphate ...	6·55
Na.	1·8	Magnesium chloride ...	1·6
CO_3	18·6	Sodium chloride	4·45
SO_4	5·25	Sodium nitrate	·2
Cl.	3·9	Silica, &c.	2·2
NO_3	·15		

Total solid constituents dried at 180° C. ... 46

Hardness: Temporary, 23°; Permanent, 17°; Total, 40°.

Free ammonia	·004
Organic ammonia	·001
Oxygen absorbed in 3 hours at 37° C.	·009
Nitrites	nil

Goldhanger.

Public well in the village street, about ½ mile from sea-wall, see pp. 163, 164. By Dr. J. C. THRESH.

The well is in a small badly-drained village (1898).

A.—As effected by subsoil-water. 1898.
B.—After well had been repaired. November, 1899.
C.—In 1900.

In parts per 100,000

	A	B	C
Calcium carbonate	9·	3·	2·
Magnesium carbonate	4·5	1·9	1·5
Sodium carbonate	21·9	31·2	15·5
Sodium sulphate	9·3	9·6	9·3
Sodium chloride	94·4	102·4	70·6
Sodium nitrate	5·9	·9	·5
Silica, &c.	2·	—	·6
Total solid constituents dried at 180° C.	147	149	100
Hardness: Temporary ...	9°	3°	—
Permanent ...	5°	4°	—
Total	14°	7°	5°
Free ammonia	·08	·092	·116
Organic ammonia	·006	·004	·002
Oxygen absorbed in 3 hours at 37° C.	·084	·08	·084
Nitrites	—	nil	nil

C.—Dull. Faintly yellow. No odour. Reaction alkaline.

Grays.

1. Grays Chalk Pits.

Made by Dr. LETHEBY. Communicated by Prof. D. T. ANSTED, 1878.

(? Grains per gallon.)

	Nov., 1861.		Dec., 1863.
Total solids	25·67	...	29·03
Carbonates of lime and magnesia	17·08	...	16·2
Sulphate of lime	2·91	...	4·65
Chloride of sodium	3·02	...	3·46
Alkaline nitrates	1·15	...	3·16
Organic matter	·57	...	·92
Silica, alumina, &c....	·94	...	·64

Grays, cont.

2. Seabrooke's Brewery. See p. 165.

Communicated by Messrs. Isler.

Water from 5-in. artesian tube-well, bored to 500 ft.

Chlorine determinations of water samples taken at different depths (? while in course of construction) in 1886, 7.

Depth in feet.		Chlorine in grains per gallon.
99		30·8
150	1st sample	42·56
	2nd ,,	43·4
170	1st ,,	43·4
	2nd ,,	43·4
190	2nd ,,	47·6
Between 194 and 215		48·3
238		107·1
274 (Feb. 3rd)		100·8
274 (Feb. 7th)		147·
295		157·5
380		92·4
406		105·
409 (May 21st)		91·
409 (June 11th)		94·5
409 (July 7th)		96·18
496 (after 18 hours pumping)		79·58

The following is an analysis of the water from this well :—

By Dr. J. C. Thresh. 7th April, 1899.

		Probably combined as :—	In parts per 100,000
Ca.	16·9	Calcium carbonate	27·2
Mg.	2·5	Calcium sulphate	12·2
Na.	24·7	Calcium nitrate	4·6
CO_3	16·3	Calcium chloride	3·4
SO_4	8·6	Magnesium chloride	9·9
Cl.	47·5	Sodium chloride	62·7
NO_3	3·5	Silica, alumina, &c.	3·5
		Total solid constituents dried at 180° C.	123·5

Hardness: Temporary, 26°; Permanent, 14°; Total, 40°.

Free ammonia	·04
Organic ammonia	·002
Oxygen absorbed in 3 hours at 37° C.	·022
Nitrites	nil

3. South Essex Water Co.

Two analyses from the *Sixth Rep. Riv. Poll. Comm.*, p. 100 (repeated on p. 293).

A.—Well. 15th February, 1873.
B.—Open shaft at the waterworks. 15th February, 1873.

	In parts per 100,000 A	B
Temperature. Centigrade	8·8°	10·8°
Total solid impurity	41·74	44·8
Organic carbon	·058	·064
Organic nitrogen	·018	·017
Ammonia	·000	·001
Nitrogen as nitrates and nitrites	·908	·929

Grays, cont.

	In parts per 100,000 A	B
Total combined nitrogen	·926	·947
*Previous sewage or animal contamination	8760	8980
Chlorine	4·7	5·05
Hardness: Temporary ...	18·6	20·7
Permanent ...	7·4	8·7
Total	26	29·4

Remarks—Both clear and palatable.

* For explanation of previous sewage contamination, see **Colchester**, p. 348.

These samples are two of many Chalk waters which are favourably spoken of for ordinary public supply purposes.

South Essex Water Works Co., Water supplied by.

Five analyses.

A.—1866. Mean of three analyses by Dr. D. Campbell, Dr. D. Thompson and Dr. Voelcker.

B.—February, 1873. Mean of two analyses by Dr. Frankland, from *Sixth Rep. Riv. Poll. Comm.*

C.—April, 1878. By Dr. Tidy.

D.—May, 1878. Mean of two analyses by Dr. Bernays.

E.—June, 1878. Mean of two analyses by Dr. Bernays.

In parts per 100,000

	A	B	C	D	E
Total solid matter ...	38·26	43·27	48·74	47·43	47·1
Lime	14·14	—	17·6	15·13	15·44
Magnesia	·877	—	1·59	1·4	1·37
Chlorine	2·47	4·87	6·79	6·13	6·29
Nitric acid	1·87	·919	4·701	3·686	3·729
Organic carbon ...	—	·061	·036	—	·07
Organic nitrogen ...	—	·017	·003	—	·015
Hardness before boiling	18·28°	19·39°	20°	18·78°	18·41°
„ after boiling ...	5·25°	5·63°	5·1°	4·74°	5·67°

South Essex Water Co. In exposed chalk (quarry). 17th June, 1911.

By Dr. J. C. Thresh.

In parts per 100,000

		Probably combined as :—	
Ca.	8·	Calcium carbonate	15·8
Mg.	·35	Calcium sulphate...	4·95
Na.	3·45	Calcium chloride	·7
CO_3	9·5	Magnesium chloride	1·5
SO_4	3·5	Sodium chloride ...	4·95
Cl.	4·6	Sodium nitrate ...	5·6
NO_3	4·1	Silica, &c. ...	1·5

Total solid constituents dried at 180° C. 35·

Hardness: Temporary, 12°; Permanent, 10°; Total, 22°.

Free ammonia ...	·000
Organic ammonia ...	·001
Nitrites	nil

Very clear. Colourless. No odour.

Great Baddow.

1. Baddow Brewery Co. See p. 166.
Dr. V. H. Veley.

1.—October, 1895. Before the mishap (boring choked with sand).
2.—After completion of new works, 1905.

	In parts per 100,000 1 from old bore.		2 from new bore.
Sodium chloride	51·09	...	50·14
Sodium sulphate	10·47	...	11·81
Sodium carbonate	38·79	...	38·81
Calcium carbonate	2·14	...	3·21
Magnesium carbonate	·71	...	·9
Ferric oxide	1·14	...	·6
Silica, &c.		...	2·51
Total dissolved residue, dried at 100° C.	106·8	...	108·

2 Galleywood Common. Well in garden behind cottage. 100 yds. from 'The Eagle.' Lead poisoning suspected. See p. 167.
By Dr. J. C. Thresh. 26th September, 1905.

		Probably combined as:—	In parts per 100,000
Ca.	7·3	Lead carbonate	·4
Mg.	·75	Calcium carbonate	1·35
Pb.	·3	Calcium sulphate	11·85
K.	1·6	Calcium chloride	9·05
Na.	7·8	Magnesium chloride	2·9
CO_3	·9	Sodium chloride	1·25
SO_4	8·35	Potassium nitrate	4·15
Cl.	8·7	Sodium nitrate	19·8
NO_3	15·1	Etc.	2·75
		Total solid constituents dried at 180° C.	53·5

Hardness: Temporary, 1°; Permanent, 26°; Total, 27°.

Clear and bright. Faintly yellow. No smell.

Contained ·7 milligrams of Free Oxygen per 100 cubic centimetres and 1·9 milligrams of Carbonic Acid Gas (CO_2) over and above what was necessary to bi-carbonate the carbonates.

There are (September, 1905) lead pipes in the well and to the house.

Two adults suffered from lead-poisoning. A child who drank only distilled water was not affected.

3. Waterworks (Chelmsford Rural District Council) Well of 1901.
See pp. 166, 167.
A. March, 1902. *B*. 13th March, 1912.
By Dr. J. C. Thresh.

	A	B	Probably combined as:—	A (In parts per 100,000)	B
Ca.	·8	·7	Calcium carbonate	2·	1·75
Mg.	·325	·35	Magnesium carbonate	1·1	1·21
Na.	42·65	43·53	Sodium carbonate	33·9	34·29
CO_3	21·2	21·3	Sodium sulphate	10·8	8·14
SO_4	7·3	5·5	Sodium chloride	62·05	65·97
Cl.	37·6	40·	Sodium nitrate	1·65	·08
NO_3	·2	·06	Etc.		·56
			Total solid constituents dried at 180° C.	111·5	112·
			Hardness: Total	4°	4°
			Free ammonia	·08	·082
			Organic ammonia	·002	·002
			Oxygen absorbed in 3 hours at 37° C.	·012	·04
			Nitrites	nil	nil

Great Bentley.

Clacton Waterworks. Trial-bore made 1898. See p. 167.
By Dr. J. C. Thresh, just after completion of boring.

			In parts per 100,000
Ca.	2·4	Probably combined as :—	
Mg.	·6	Calcium carbonate ...	6·
Na.	11·3	Magnesium carbonate ...	2·1
CO_3	16·6	Sodium carbonate ...	20·3
SO_4	1·9	Sodium sulphate ...	2·8
Cl.	2·4	Sodium chloride	4·
NO_3	0	Silica, oxide of iron, &c.	·8
		Total solid constituents dried at 180° C....	36·
		Hardness : Total	9°
		Free ammonia	·001
		Organic ammonia	·005
		Oxygen absorbed in 3 hours at 37° C....	·068

Great Bromley.

The Lodge. By Dr. J. C. Thresh. May, 1898.

			In parts per 100,000
Ca.	1·3	Probably combined as :—	
Mg.	1·	Calcium carbonate ...	3·25
Na.	47·5	Magnesium carbonate ...	3·5
CO_3	18·7	Sodium carbonate ...	25·15
SO_4	10·	Sodium sulphate	14·8
Cl.	48·8	Sodium chloride	80·5
NO_3	·3	Sodium nitrate	·4
		Silica, &c.	·9
		Total solid constituents dried at 180° C....	128·5
		Hardness : Total	7°
		Free ammonia	·000
		Organic ammonia	·001
		Oxygen absorbed in 3 hours at 37° C.	·044
		Nitrites	nil.

Great Chesterford.

Park Road. A little northward of the church (through deep Drift to Chalk). See p. 169.
By Prof. J. Attfield. 1894.

	In parts per 100,000
Total suspended solid matter	2·86
Total dissolved solid matter	41·43
Chlorides, containing 60 per cent. of chlorine...	2·86
= Chlorine	1·71
Nitrates, containing 17 per cent. of nitrogen ...	1·06
= Nitrogen	·176
Nitrites	nil.
Free ammonia	·0008
Albuminoid ammonia	nil.
Oxygen absorbed in 3 hours	·0014

Hardness : Permanent 6° ; Temporary 17° ; Total 23°.

There was a slight chalky sediment.

Remarkably free from contamination by organic matter. Contains much inorganic (mineral) matter causing hardness. Of good quality for drinking purposes.

Great Coggeshall, see Coggeshall.

Great Dunmow.

A.—Isolation Hospital. Bored 1903, 286 ft. deep. See p. 170. April, 1908.

B.—Public supply from Dunmow Waterworks (well 300 ft. deep). See pp. 170, 171. 23rd November, 1911.

C.—Dunmow Brewery, North Street (well 400 ft. deep). See p. 171. 19th April, 1899.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	C	Probably combined as :—	A	B	C
Ca.	10·4	10·	9·4				
Mg.	2·3	2·3	2·8	Calcium carbonate	26·	25·	23·5
Na.	5·2	4·8	3·8	Magnesium carbonate	4·1	5·3	5·2
CO_3	18·5	18·8	17·8	Magnesium sulphate	5·4	4·	6·5
SO_4	7·7	7·4	6·7	Sodium sulphate ...	5·	6·2	2·3
Cl.	5·4	4·	4·1	Sodium chloride ...	8·9	6·6	6·75
NO_3	·3	·4	·9	Sodium nitrate ...	·4	·6	1·25
				Silica, &c.	·2	·8	1·5
				Total solid constituents dried at 180° C.	50·	48·5	47·
				Hardness: Temporary	—	20·5°	25°
				Permanent ...	—	13·5°	11°
				Total ...	35°	34°	36°
				Free ammonia	·024	·005	·007
				Organic ammonia	·002	—	·003
				Oxygen absorbed in 3 hours at 37° C. ...	·025	·023	·015
				Nitrites	nil	nil	nil

B.—Clear and bright. No deposit. Practically colourless. No odour. Reaction neutral.

C.—No turbidity. Clear. Faintly yellow.

Great Saling.

Saling Grove. Well over 385 ft. deep (in Chalk). See p. 174.

By Dr. J. C. Thresh. 25th April, 1912.

In parts per 100,000

		Probably combined as :—	
Ca.	2·35	Calcium carbonate ...	5·88
Mg.	1·5	Magnesium carbonate ...	5·19
Na.	25·25	Sodium carbonate ...	16·42
CO_3	16·5	Sodium sulphate	10·2
SO_4	6·9	Sodium chloride	37·4
Cl.	22·7	Sodium nitrate	·41
NO_3	·3	Etc.	·5
		Total solid constituents dried at 180° C....	76·
		Hardness: Temporary	11°
		Permanent	1°
		Total	12°
		Free ammonia	·016
		Organic ammonia	·011
		Oxygen absorbed in 3 hours at 37° C. ...	·035
		Nitrites	nil.

Clear—of good appearance. No deposit. Faint greyish yellow. No odour.

Great Wakering.

A.—Pumping station. Southend Water Co. See p. 175. 28th December, 1908.
B.—Rutter's well and boring (of 1902). Made for supplying the brickyard. See p. 176. 18th February, 1902.
By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as -:—	A	B
Ca.	·7	·75	Calcium carbonate	1·75	1·9
Mg.	·3	·4	Magnesium carbonate ...	1·05	1·4
Na.	38·35	38·15	Sodium carbonate	28·8	31·4
CO_3	18·1	20·	Sodium sulphate	9·35	9·75
SO_4	6·35	6·6	Sodium chloride	57·75	54·45
Cl.	35·	33·	Sodium nitrate	·3	1·1
NO_3	·2	·1	Etc.	1·5	
			Total solid constituents dried at 180° C.	100·5	100·
			Hardness: Total	4·3°	3·6°
			Free ammonia	·056	·072
			Organic ammonia	·007	·001
			Oxygen absorbed in 4 hours at 37° C.	·088	·02
			Nitrites	nil	nil

Great Waltham.

Shallow well at Mr. Tuffnell's new cottages (1900). See p. 176.
By Dr. J. C. Thresh. November, 1900.

In parts per 100,000

		Probably combined as :—	
Ca.	13·8	Calcium carbonate ...	34·5
Mg.	1·9	Magnesium carbonate ...	·85
Na.	4·25	Magnesium sulphate ...	8·25
CO_3	21·3	Sodium sulphate	7·55
SO_4	11·7	Sodium chloride	3·65
Cl.	2·2	Sodium nitrate	1·25
NO_3	·9	Silica, &c.	1·95
H_2S.	trace		
		Total solid constituents dried at 180° C. ...	58·
		Hardness: Total	43°
		Free ammonia	·016
		Organic ammonia	·008
		Oxygen absorbed in 3 hours at 37° C. ...	·202
		Nitrites	—

Dull. Yellow. Reaction neutral. Smelt strongly of Sulphuretted Hydrogen (H_2S); the smell quickly disappeared on exposure to air.

Three years later the water from the well suddenly ceased to smell (it had been left open) and the well was finished and covered. In 1910 there was still no smell.

Great Warley.

Ilford Limited. Factory. Warley Common. 11th February, 1914. From the boring 1,002 ft. deep, see p. 177.
By Dr. J. C. Thresh.

In parts per 100,000

		Probably combined as :—	
Ca.	1·	Calcium carbonate	2·5
Mg.	·1	Magnesium carbonate	·35
Na.	26·1	Sodium carbonate	30·85
CO_3	19·2	Sodium sulphate	13·6
SO_4	9·2	Sodium chloride	21·1
Cl.	12·8	Silica, &c.	1·6
NO_3	0		
		Total solid constituents dried at 180° C.	70·

Hardness: Temporary 2·5; Permanent ·5; Total 3·.

Great Warley, cont.

	In parts per 100,000
Free ammonia	·0264
Organic ammonia	·0036
Oxygen absorbed in 3 hours at 37° C.	·028
Nitrites	nil.

Turbidity. Trace of fine sandy deposit. Colour faint yellow-green. No odour. Faintly alkaline.

Hadleigh.

Salvation Army Colony. Well No. 1, 200 yds. south-west of church. See pp. 177, 178.

By Dr. J. C. Thresh. 10th November, 1902.

		Probably combined as :—	In parts per 100,000
Ca.	·85	Calcium carbonate ...	2·1
Mg.	·5	Magnesium carbonate ...	1·75
Na.	34·55	Sodium carbonate ...	27·
CO_3	17·8	Sodium sulphate	9·65
SO_4	6·5	Sodium chloride	50·
Cl.	30·3	Silica, &c.	1·5
NO_3	0		
		Total solid constituents dried at 180° C.... ...	92·

Hardness :		
	Temporary	2°
	Permanent	2°
	Total	4°

Free ammonia	·0276
Organic ammonia	·002
Oxygen absorbed in 3 hours at 37° C....	·0292
Nitrites	nil.

No **turbidity.**

Hadstock.

New House Farm. See p. 178.

By Dr. J. C. Thresh. 23rd June, 1913.

		Probably combined as :—	In parts per 100,000
Ca.	12·9	Calcium carbonate ...	30·
Mg.	·4	Calcium sulphate... ...	3·06
Na.	2·42	Magnesium sulphate ...	1·97
CO_3	18·	Sodium sulphate	1·14
SO_4	4·5	Sodium chloride	3·8
Cl.	2·3	Sodium nitrate	2·05
NO_3	1·5	Etc.	·98
		Total solid constituents dried at 180° C....	43

Hardness : Temporary, 28° ; Permanent, 9° ; Total, 37°.

Free ammonia	0
Organic ammonia	0
Oxygen absorbed in 3 hours at 37° C.	0
Nitrites	0

Clear and bright. No matter in suspension. Very faintly bluish. No odour. **Reaction, neutral** to Lacmoid.

Halstead.

1. Waterworks (? the well of 1860, see pp. 179, 180). Sample taken 200 ft. from surface.

By Prof. Attfield. 11th January, 1889.

	In parts per 100,000
Total suspended solid matter dried at 250° F.	none.
Total dissolved ,, ,, ,,	45·71
Ammonia	·007
Ammonia albuminoid	·002
Nitrites	nil.
Nitrates	nil.
Chlorine	6
Hardness in chalk grains or degrees removed by boiling	14· } 18
,, ,, ,, unaffected ,,	4· }
Lead or copper	none.
Oxygen absorbed in 3 hours	·043

Physical examination satisfactory.

2. Waterworks and Railway.

A.—Public water-supply. From the well made 1890. 22nd June, 1899.
B.—Same. 16th June, 1911.
C.—Halstead railway-station. New deep Chalk well. January, 1901.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	C
Ca.	9·25	10·1	10·4
Mg.	1·65	1·3	1·4
Na.	6·95	5·59	3·
CO_3	16·8	16·8	17·
SO_4	3·7	2·3	3·4
Cl.	8·7	8·6	4·45
NO_3	·17	·25	·3

Probably combined as :—	A	B	C
Calcium carbonate	23·15	25·25	26·
Magnesium carbonate	4·05	2·32	1·95
Magnesium sulphate	2·5	2·88	4·25
Magnesium chloride	—	·19	—
Sodium sulphate	2·5	—	—
Sodium chloride	14·35	13·96	7·35
Sodium nitrate	·2	·34	·4
Silica, etc....	1·25	1·06	1·65
Total solid constituents dried at 180° C.	48·	46·	41·6
Hardness : Temporary	25·5°	24·°	—
Permanent	5·°	7·°	—
Total	30·5°	31·°	—
Free ammonia	·02	·016	·0063
Organic ammonia	·000	·001	·0052
Oxygen absorbed in 3 hours at 37° C.	·022	·012	·018
Nitrites	nil	nil	nil

A.—No turbidity. Clear and bright.
B.—Fairly clear. Slightly yellow. No odour.

Harwich and Dovercourt.

G. W. Wigner. The Water Supply of Sea-side Watering Places, 1878, pp. 11–14.

The supply was partly from a deep well, but it was insufficient. The inhabitants were dissatisfied with the supply, and water from public pumps was taken round in carts.

A.—Presumably from the well. Sample taken from a main pipe.
B.—Barrack-pump, public, said to come from a well 30 ft. deep.
C.—From another pump, supplying a large number of houses.
D.—From a private pump, supplying some good houses.

Harwich and **Dovercourt,** cont.

In parts per 100,000

	A	B	C	D
Total solid matter	172·57	87·71	156·29	116·14
Loss on ignition, after deducting combined CO_2	14·83	20·63	34·86	29·23
Iron	trace.	trace.	0	0
Chlorine calculated as sodium-chloride	132·04	18·39	52·31	29·121
Hardness before boiling, Clark's scale	25°	36°	57°	30°
Hardness after boiling	19°	27°	47°	24°
Nitrogen as ammonia	·099	·0091	·0063	·0023
,, albuminoid ammonia ...	·0063	·0089	·0057	·005
,, nitrates	·6567	2·483	2·2606	4·59
,, nitrites	·0086	·0086	·0103	·0071
Total nitrogen in the four forms ...	·7706	2·5366	2·283	4·601
Oxygen absorbed by organic matter	·0091	·064	·0137	·0046

A.—Water turbid. Free from smell. Briny taste. Clearly there is infiltration of sea-water. Microscopic examination, apparently free from organic matter.

B.—Water pale yellow. Had slightly offensive smell, and when warmed an offensive taste. Microscopic examination showed the presence of a great deal of vegetable fibre.

C.—Water pale blue. Comparatively free from smell. Soapy alkaline taste. Microscopic examination fairly satisfactory.

D.—Water pale blue. Tolerably free from smell, but when heated a slight smell of urine perceptible. Microscopic examination showed contamination from organic matter. Nitrates excessive.

The above refers, of course, to a past state of things.

Hatfield Peverel.

A.—Crab's Hill. Well 406 ft. deep. See pp. 186, 187. 31st March, 1908.

B.—Hatfield Place. Well of 1900 (340 ft. deep). See p. 186. 27th November, 1900.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	1	1·4	Calcium carbonate	2·5	3·5
Mg.	·5	·5	Magnesium carbonate ...	1·75	1·75
Na.	49·33	48·4	Sodium carbonate	31·35	36·45
CO_3	20·4	24·	Sodium sulphate	16·3	15·55
SO_4	11·	10·5	Sodium chloride	76·9	69·95
Cl.	46·6	42·4	Sodium nitrate	·15	1·3
NO_3	·13	·2	Silica, &c.	2·05	
			Total solid constituents dried at 180° C. ...	131·	128·5
			Hardness: Temporary	—	4°
			Permanent	—	3°
			Total	6·5°	7°
			Free ammonia	·116	·08
			Organic ammonia	·003	·002
			Oxygen absorbed in 3 hours at 37° C.	·04	·02
			Nitrites	nil	nil

A.—Clear. Very faint yellow.

B.—Turbid with suspended chalk (well barely finished).

Havering.

Pyrgo Park (second well, 665½ ft. deep). See p. 187.

By Dr. J. C. Thresh. 12th April, 1899.

		Probably combined as :	In parts per 100,000
Ca.	·85	Calcium carbonate	2·1
Mg.	·35	Magnesium carbonate	1·2
Na.	25·4	Sodium carbonate	26·65
Fe.	trace.	Sodium sulphate	15·8
CO_3	17·2	Sodium chloride	22·1
SO_4	10·7	Ferric oxide, alumina oxide,	
Cl.	13·4	silica, &c.	2·65
NO_3	·01		
		Total solid constituents dried at 180°C.	70·5

Hardness : Temporary, 6·5°; Permanent, ·5°; Total, 7°.

Free ammonia	·076
Organic ammonia	·000
Oxygen absorbed in 3 hours at 37° C. ...	·023
Nitrites	nil.

Decided yellow tint. A little fine sandy sediment.

Helion Bumpstead.

A.—Pale Green, deep well, see p. 188. 20th December, 1909.

B.—Well in the village, see p. 188. 20th December, 1909.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	36·5	19·5	Calcium carbonate	40·3	25·5
Mg.	11·8	3·2	Calcium sulphate	69·3	31·6
Na.	27·2	13·2	Magnesium sulphate ...	58·3	15·8
CO_3	24·2	15·3	Sodium sulphate	43·4	2·9
SO_4	124·8	36·9	Sodium chloride	29·7	25·4
Cl.	18·	15·4	Sodium nitrate	5·5	8·5
NO_3	4·	6·2	Water of hydration... ...	8·8	—
			Silica, &c.	1·7	1·3
			Total solid constituents dried at 180° C.	257·	111·
			Hardness : Temporary ...	56°	—
			Permanent ...	98°	—
			Total ...	154°	over 60°
			Free ammonia	·011	·001
			Organic ammonia	·006	·025
			Oxygen absorbed in 3 hours at 37° C. ...	·084	·224
			Nitrites	small trace.	nil.

A.—Dull and chalky. Colour greyish. No odour. Reaction neutral.

B.—Dull and chalky. Greyish. No odour. Reaction neutral.

Heybridge.

Analyses by Dr. J. C. Thresh.

For sections, etc., of *A*, *B*, *E*, *F*, see pp. 190, 191.

B, *C*, and *D*.—Public well at Heybridge Basin, about 20 yds. north of the lock-gates and a few yards from a tidal creek.

In parts per 100,000.

	A	B	C	D	E	F
	Heybridge Ironworks, 22nd June, 1899.	25th May, 1900. Well just put in good order. Earthenware tubes, etc.	25th May, 1908.	21st September, 1908, after a deepening of the boring.	He, bridge, Hall (well of 1908), 15th February, 1908.	Saltcote Hall. Boring of 1912. 6th September, 1912.
Calcium carbonate ...	3·	3·25	3·25	9·	6·9	3·75
Magnesium-carbonate	2·45	1·9	1·9	5·5	5·25	3·46
Ferrous carbonate ...	—	—	—	—	1·	—
Sodium-carbonate ...	31·85	34·75	34·75	25·1	28·75	32·49
Sodium-sulphate ...	13·7	16·3	16·3	16·8	19·25	15·15
Sodium-chloride ...	85·8	69·8	69·8	128·8	155·1	90·
Sodium-nitrate ...	·55	·2	·2	·4	—	·23
Difference	·35	—	—	—	—	—
Silica, &c.	—	1·3	1·3	·4	2·75	·92
Total solid constituents dried at 180 C. ...	137·7	127·5	127·5	186·	219·	146· (some iron).
Hardness: Temporary	5·5°	3°	3°	19°	—	—
Permanent	1·5°	2°	2°	2°	—	—
Total ...	7°	5°	5°	21°	13°	10°
Free ammonia ...	·001	·056	·056	·12	·12	·132
Organic ammonia ...	·000	·002	·002	·004	·002	·006
Oxygen absorbed ...	·048	·088	·008	·092	—	—
Nitrites	nil	nil	minute trace.	nil	minute trace.	nil

A.—Contains a little fine sand. Harrington's well near by gave almost identical Ca. and CO_3.

B.—Contained a little very fine sand.

E.—A few weeks later the Chlorine (Sodium Chloride) was only about two-thirds of the figure here and the Iron (Ferrous Carb.) was also less. Sodium Chloride so high as to suggest that the sample was from an old well abandoned through tidal infiltration.

F.—Thick (deposit of iron). Yellow. No odour. Reaction neutral.

High Laver.

Rectory (well 200 ft. deep). Sample taken after pumping out all the water and then allowing it to rise 10 ft. (The rest-level is only 50 ft. down.) See p. 192. By Dr. J. C. Thresh. 18th October, 1909.

In parts per 100,000

		Probably combined as :—	
Ca.	6·6	Calcium carbonate ...	16·5
Mg.	·85	Magnesium carbonate ...	2·95
Na.	15·2	Sodium carbonate ...	11·4
Fe.	trace.	Sodium sulphate ...	21·9
CO_3	18·4	Sodium chloride	7·6
SO_4	14·8	Sodium nitrate	·4
Cl.	4·6	Silica, deposit, &c. ...	2·25
NO_3	·3		
		Total solid constituents dried at 180° C	63·

High Laver, cont.

		In parts per 100,000
Hardness:	Temporary ...	14°
	Permanent ...	6°
	Total	20°

Free ammonia	·002
Organic ammonia	·028
Oxygen absorbed in 3 hours at 37° C.	·21
Nitrites	nil.

Turbidity. Considerable sediment containing vegetable debris, rotifers, etc. Faint yellow. No odour. Reaction alkaline.

Hornchurch.

South Essex Water Co.'s well. Near Dagenham (see p. 193).

By Dr. J. C. Thresh. 17th June, 1911.

		Probably combined as :—	In parts per 100,000
Ca.	5·5	Calcium carbonate ...	13·75
Mg.	1·88	Magnesium carbonate ...	6·5
Na.	7·06	Sodium carbonate ...	5·57
CO_3	16·1	Sodium sulphate	5·03
SO_4	3·4	Sodium chloride	7·75
Cl.	4·7	Sodium nitrate	·16
NO_3	·12	Silica, &c.	1·24
		Total solid constituents dried at 180° C....	40

Hardness: Temporary, 17°; Permanent, 7°; Total, 24°.

Free ammonia	·008
Organic ammonia	·003
Oxygen absorbed in 3 hours at 37° C.	·032
Nitrites	nil.

Very clear. Very slightly yellow. No odour.

Ilford.

1. Chadwell Heath. West Ham Asylum. Well sunk 1900. See p. 197.

By Dr. J. C. Thresh. 8th December, 1900.

		Probably combined as :—	In parts per 100,000
Ca.	2·4		
Mg.	1·4	Calcium carbonate	6·
Na.	20·5	Magnesium carbonate	4·9
CO_3	14·7	Sodium carbonate	13·4
SO_4	14·3	Sodium sulphate	21·15
Cl.	12·1	Sodium chloride	19·95
NO_3	—	Traces of Ferric oxide, silica, &c.	3·1
		Total solid constituents dried at 180° C....	68·5

Slightly turbid, probably from long standing in pipes.

Ilford, cont.

2. Various Ilford Wells.

A.—Electric Light Station. (Well of 1901 or early 1902.) See p. 199. 15th October, 1902.
B.—Britannia Works (now the Ilford Co.). Well, ? newer one, 325 ft. deep. See p. 196. 8th December, 1900 ?
C.—Paper Mills. Eckman Pulp Co. At river-bridge (? newer well, 280 ft. deep). 8th December, 1900.
D.—Howard's Chemical Works. See p. 200. 8th December, 1900.
E.—Great Eastern Railway Works. Taken direct from pump. See p. 199. 6th July, 1909.

By Dr. J. C. Thresh.

	A	B	C	D	E
Ca.	1·35	1·3	1·85	1·5	3·
Mg.	·75	·6	·7	·75	1·57
Na.	17·85	15·45	15·4	14·35	18·1
CO_3	15·4	14·8	15·1	14·75	16·4
SO_4	10·7	8·2	8·	7·	13·9
Cl.	6·	4·4	5·4	4·4	7·8
NO_3	·13	·1	trace	minute trace.	1·1

In parts per 100,000

	A	B	C	D	E
Probably combined as :—					
Calcium carbonate ...	3·35	3·25	4·65	3·75	7·5
Magnesium carbonate ...	2·65	2·1	2·45	2·65	5·4
Sodium carbonate ...	20·3	20·	18·65	18·7	14·1
Sodium sulphate	15·85	12·1	11·8	10·35	20·5
Sodium chloride	9·9	7·3	8·9	7·3	12·8
Sodium nitrate	·2	·15	trace	trace	1·5
Etc.	·75	3·3	2·15	1·75	1·2
Total solid constituents dried at 180° C.	53·	48·2	48·6	44·5	63·
Hardness: Temporary ...	7·3°	—	—	—	—
Permanent	·7°	—	—	—	—
Total	8·°	5·5°	8·1°	7·9°	13·°
Free ammonia	·064	·03	·032	·054	·094
Organic ammonia	·006	·002	·004	·0048	·001
Oxygen absorbed in 3 hours at 37° C. ...	·024	·02	·019	·016	·006
Nitrites	nil	nil	nil	nil	nil

Ilford, cont.

3. Ilford Wells. Public Supply.

A.—Metropolitan Water Board Works (really in Wanstead, see p. 295). 14th December, 1911.
B.—South Essex Water Co. Ilford Well. See p. 198. 4th July, 1911.
C.— " " " 17th June, 1911.
D.— " " Roding Well, near Roding Bridge, Fernhill. See p. 198. 17th June, 1911.

By Dr. J. C. Thresh.

	A	B	C	D
Ca.	4·	2·1	1·9	2·1
Mg.	1·2	·64	·5	1·15
Na.	10·2	13·85	14·3	10·38
CO_3	13·6	14·6	14·6	13·4
SO_4	9·6	6·9	7·2	5·5
Cl.	3·	4·4	4·1	3·1
NO_3	·27	·28	·12	·12

In parts per 100,000

Probably combined as :—	A	B	C	D
Calcium carbonate	10·	5·25	4·75	5·25
Magnesium carbonate ...	4·1	2·21	1·73	3·95
Sodium carbonate	8·3	17·5	18·62	13·15
Sodium sulphate	14·2	10·2	10·66	8·14
Sodium chloride	4·9	7·25	6·8	5·1
Sodium nitrate	·37	·38	·16	·16
Silica, alumina, &c.	·13	2·21	1·28	1·75
Total solid constituents dried at 180° C. ...	42·	45·	44·	37·5
Hardness : Temporary	12°	8·°	6·5°	7·5
Permanent	5°	1·°	1·°	1·5
Total	17°	9·°	7·5°	9·
Free ammonia	·000	—	·049	·041
Organic ammonia	·003	—	·002	·0025
Oxygen absorbed in 3 hours at 37° C. ...	·029	—	·025	·028
Nitrites	nil	—	very slight trace.	—

B.—Contained a trace of iron. Clear. Very slight greyish yellow. No odour.
C.—Clear. Slightly greyish. No odour.
D.—Very clear. Very slight yellow. No odour.

Ilford, cont.

4. Barking Side. Dr. Barnardo's Homes. See pp. 195, 196.
By Dr. J. C. Thresh. 24th October, 1909.

In parts per 100,000

		Probably combined as :—	
Ca.	1·85	Calcium carbonate ...	4·6
Mg.	·75	Magnesium carbonate ...	2·55
Na.	17·8	Sodium carbonate ...	17·7
CO_3	14·6	Sodium sulphate	15·5
SO_4	10·5	Sodium chloride	12·9
Cl.	7·8	Etc.	·75
NO_3	trace.		
		Total solid constituents dried at 180° C....	54·

Ingatestone.

A.—Well (1901) 801 ft. deep. See pp. 200, 201. 17th December, 1911. Sample taken after 14 days' trial-pumping.
B.—Do. 15th April, 1912.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	·56	·88	Calcium carbonate	1·4	2·18
Mg.	·38	·3	Magnesium carbonate ...	1·3	1·04
Na.	30·75	30·76	Sodium carbonate	29·15	29·46
CO_3	18·3	18·7	Sodium sulphate	9·6	8·6
SO_4	6·5	5·8	Sodium chloride	38·1	38·4
Cl.	23·1	23·3	Sodium nitrate	—	·24
NO_3	·19	·18	Alumina, silica, &c. ...	·45	·08
			Total solid constituents dried at 180° C.	80·	80·
			Hardness : Temporary	2°	—
			Permanent	1°	—
			Total	3°	4°
			Free ammonia	·068	·04
			Organic ammonia	·000	·0015
			Oxygen absorbed in 3 hours at 37° C.	·024	·04
			Nitrites	nil	nil

A.—Turbidity. Very faint trace of suspended chalk when drawn; this cleared quickly.

B.—Clear and bright. Excellent appearance. Very faint yellow. No odour. Reaction neutral.

Inworth.

1. Public supply of Tiptree. See p. 202.
By Dr. J. C. Thresh. 29th November, 1909.
Sample from reservoir at waterworks.

In parts per 100,000

		Probably combined as :—	
Ca.	2·8	Calcium carbonate ...	5·
Mg.	·4	Calcium sulphate... ...	2·7
Na.	2·05	Magnesium sulphate ...	1·
CO_3	3·	Magnesium chloride ...	·8
SO_4	2·7	Sodium chloride	2·5
Cl.	2·1	Sodium nitrate	3·95
NO_3	2·9	Silica, &c.	·55
		Total solid constituents dried at 180° C....	16·5

Hardness : Temporary, 7° ; Permanent, 1·5° ; Total, 8·5°.

Free ammonia	·002
Organic ammonia	·01
Oxygen absorbed in 3 hours at 37° C.	·052
Nitrites	nil.

Inworth, cont.

2. Inworth Grange. Shallow well (26 ft. deep).

By Dr. J. C. Thresh. March, 1910.

In parts per 100,000

		Probably combined as :—	
Ca.	7·4	Zinc carbonate	3·65
Mg.	1·7	Calcium carbonate ...	11·05
Na.	8·4	Calcium sulphate... ...	10·2
Zn.	1·9	Magnesium sulphate ...	6·
CO_3	8·4	Magnesium chloride ...	1·95
SO_4	12·	Sodium chloride	17·05
Cl.	11·8	Sodium nitrate	6·2
NO_3	4·5	Etc.	·9
		Total solid constituents dried at 180° C....	57·

Hardness: Temporary, 12°; Permanent, 18°; Total, 30°.

Free ammonia	·008
Organic ammonia	·005
Oxygen absorbed in 3 hours at 37° C.	·043
Nitrites	nil.

Clear, very faint yellow. No odour. Reaction slightly acid.

Acted powerfully on galvanised iron pipe through which it passed: hence the zinc-carbonate.

Kelvedon.

A.—Fuller's Brewery. Well of 1887 (383 ft. deep). See p. 202. 3rd June, 1899.

B.—Well 30 to 40 ft. deep at 'The Poplars,' High Street. 4th January, 1912.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	1·6	9·5	Calcium carbonate	4·	17·5
Mg.	1·25	·5	Calcium sulphate	—	8·5
Na.	31·95	2·1	Magnesium carbonate ...	4·35	—
K.	3·4	—	Magnesium sulphate ...	—	2·5
Al_2O_3	2·4	—	Sodium carbonate	27·6	—
NH_4	—	1·3	Sodium sulphate	7·9	—
CO_3	21·2	10·5	Potassium chloride	6·5	—
SO_4	5·35	8·	Sodium chloride	43·7	5·4
Cl.	30·6	3·3	Sodium nitrate	1·1	5·7
NO_3	·8	4·4	Alumina oxide	2·4	—
			Silica, &c.	2·95	·4
			Total solid constituents dried at 180° C. ...	100·5	40·

	A	B
Hardness: Temporary ...	9·5°	—
Permanent ...	·5°	—
Total ...	10°	23°
Free ammonia	·064	*1·12
Organic ammonia	0	·07
Oxygen absorbed in 3 hours at 37° C. ...	·006	·6
Nitrites	nil.	—

* This very high figure is noticeable and nothing was found to account for it.

A.—No turbidity; clear, etc.

Laindon and Laindon Hill.

A.—Laindon Hill. New well. April, 1898. See p. 205.

B.—Laindon railway-station. Deep well. See pp. 203, 204. 22nd April, 1898.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	·8	·6	Calcium carbonate	2·	1·5
Mg.	·45	·3	Magnesium carbonate ...	1·55	1·05
Na.	28·38	28·05	Sodium carbonate	28·	26·2
CO_3	18·	16·5	Sodium sulphate	18·35	9·5
SO_4	12·4	6·4	Sodium chloride	25·6	34·5
Cl.	15·5	20·9	Sodium nitrate	1·6	—
NO_3	·09	·16	Silica, &c.	1·4	1·25
			Total solid constituents dried at 180° C. ...	78·5	74·
			Hardness: Temporary ...	4°	1°
			Permanent ...	0°	1°
			Total ...	4°	2°
			Free ammonia	·005	·004
			Organic ammonia	·01	·002
			Oxygen absorbed in 3 hours at 37° C. ...	·14	·064
			Nitrites	nil	nil

Laindon Hill. From trial-well for public supply (1907). See p. 205.

Made by Dr. B. Dyer. May, 1908.

In parts per 100,000

Total dissolved matter	20·
Loss on incineration of residue	2·
Chlorine in chlorides	1·59
(Equal to chloride of sodium)	2·59
Nitrogen in nitrates	·33
(Equal to nitric acid)	1·26
Free (actual or saline) ammonia	traces.
Albuminoid (organic) ammonia	·0014
Oxygen absorbed by oxidisable organic matter, &c., from a solution of permanganate of potash, at 80° F.—	
In 15 minutes	·086
In 4 hours ...	·157
Phosphoric acid	traces.
Appearance in two-foot tube	turbid.

Microscopic Examination.—A good deal of vegetable debris and many living Infusoria.

Bacteriologic Examination.—Copious contamination from unclean surface-water.

Remarks.—Cannot be regarded as a proper water for public supply unless dealt with by a very thorough system of storage and double filtration on similar lines to that applied to the Thames water by the Metropolitan Water Board.

Langenhoe.

Langenhoe Hall (well made 1902). See p. 206.

By Dr. J. C. THRESH. 22nd February, 1908.

In parts per 100,000

Ca.	1·25	Probably combined as :—	
Mg.	1·3	Calcium carbonate	3·15
Na.	29·8	Magnesium carbonate	4·55
CO_3	25·1	Sodium carbonate	36·
SO_4	12·7	Sodium sulphate	18·8
Cl.	12·	Sodium chloride	19·85
NO_3	0	A little suspended matter, &c....	1·65
Iron	0		
		Total solid constituents dried at 180° C....	84·
		Hardness : Total ...	·9°
		Free ammonia	·138
		Organic ammonia	·004
		Oxygen absorbed in 3 hours at 37° C.	·036
		Nitrites	nil.

Latchingdon.

Tyle Hall (well 475 ft. deep).—See p. 206. 18th March, 1910.

A partial earlier analysis is also included in the table following this analysis.

By Dr. J. C. THRESH.

In parts per 100,000

Ca.	·77	Probably combined as :—	
Mg.	·46	Calcium carbonate ...	1·92
Na.	42·8	Magnesium carbonate ...	1·67
CO_3	22·4	Sodium carbonate ...	35·45
SO_4	6·7	Sodium sulphate	9·9
Cl.	37·2	Sodium chloride	61·3
NO_3	·26	Sodium nitrate	·36
		Total solid constituents dried at 180° C....	110·6
		Hardness : Total ...	3°
		Free ammonia	·04
		Organic ammonia	·004
		Oxygen absorbed in 3 hours at 37° C.	·035
		Nitrites	nil.

In *Essex Nat.*, vol. vii, Dr. THRESH instances Latchingdon as a small area showing very marked variations in the qualities of its deep well-waters as indicated in the following table. All the wells are thought to be about 300 ft. deep, except that at Tyle Hall, which is 475 ft. deep. In all the source of water is supposed to be Thanet Sands.

Latchingdon, cont.

The highest and lowest figures in each column in italics.

In grains per gallon.

Well.	Total Solids.	Total Hardness	Alkalinity expressed as sodium carbonate.	Chlorine.	Nitric Nitrogen.
Nix's Farm ...	90	*3·*	25·5	28·6	·14
Ram's	92	3·5	25·	28·	·07
Tyle Hall ...	86	3·5	26·	26·6	*·03*
Sharp's	*85*	9·	26·5	28·3	·25
Lawling Hall ...	104	11·	29·5	30·	·24
Engineers' Arms	100	4·	32·	27·4	·09
Green Lane ...	150	12·5	17·5	36·	2·5
Freeman's ...	123	14·	28·	32·	·11
Police Station ...	113	19·	*17·*	*14·8*	1·44
Red Lion ...	155	27·	29·	25·6	1·5
Snoreham Hall ...	256	47·	28·7	55·2	·38
Warden's ...	162	*48·*	18·5	32·	1·97
Bullock's... ...	253	*very great.*	27·3	56·4	·99
*Hitch's	*582*	*very great.*	*34·5*	*71·*	*2·8*

* The water from this well was for many years as soft and good as any deep well-water in the parish. The yield, however, fell off and the tube was 'shelled' and deepened, when the character of the water altered either, apparently, through the breaking of the continuity of the tube in the 'shelling' and so the admission of water from less depth or from the deepening.

He adds that many wells here were disused owing to the character of the water yielded.

Lawford.

Tendring Hundred Water Co. Well, 1905. See p. 207.

By Dr. J. C. Thresh. 7th November, 1905.

In parts per 100,000

		Probably combined as :—	
Ca.	2·75		
Mg.	2·3	Calcium carbonate ...	6·85
Na.	19·41	Magnesium carbonate ...	8·05
Fe.	·01	Sodium carbonate ...	11·75
CO_3	16·5	Sodium sulphate	8·8
SO_4	5·95	Sodium chloride	29·
Cl.	17·6	Sodium nitrate	·15
NO_3	·09	Silica, &c.	1·4
		Total solid constituents dried at 180° C....	66

Hardness : Temporary, 14° ; Permanent, 2° ; Total, 16°.

Free ammonia	102
Organic ammonia	·000
Oxygen absorbed in 3 hours at 37° C.	·012
Nitrites	nil.

Layer Marney.

A.—The Towers. Boring made, 1900. See p. 208. 14th September, 1900.

B.—The Towers. Boring made, 1909. See pp. 208, 209. 16th October, 1909. After deepening to 900 ft.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	·55	2·5	Calcium carbonate	1·35	6·25
Mg.	·1	1·1	Magnesium carbonate ...	·35	3·8
Na.	47·3	73·5	Sodium carbonate	39·1	29·25
Fe.	mere trace.	—	Sodium sulphate	12·7	12·4
			Sodium chloride	66·3	144·3
CO_3	23·2	23·	Sodium nitrate	·6	—
SO_4	8·6	8·4	Etc.	1·6	—
Cl.	40·2	87·5			
NO_3	·45	—			
			Total solid constituents dried at 180° C.	122·	196·
			Hardness : Total ...	3°	12°
			Free ammonia	·08	·126
			Organic ammonia	·006	·002
			Oxygen absorbed in 3 hours at 37° C.	—	·064
			Nitrites	nil	nil

Leigh-on-Sea. (Southend).

A-F.—Well and boring for public supply, near Hop Water Farm, Hadley Road (600 ft. deep, into Chalk). Taken over by Southend Water Co. See p. 262.

A, October, 1898. *B*, 10th April, 1899. *C*, 11th May, 1900. *D*, 13th November, 1900. *E*, 28th December, 1908. *F*, 20th May, 1910.

By Dr. J. C. Thresh.

	A	B	C	D	E	F
Ca.	·55	·55	·5	·7	·7	·9
Mg.	·275	·3	·25	·3	·3	·27
Na.	30·93	31·1	31·5	31·45	32·2	33·4
CO_3	16·8	17·2	17	16·8	15·4	16·6
SO_4	5·6	5·4	5·4	5·6	5·15	5·5
Cl.	25·3	25·9	26·	26·3	29·6	30·3
NO_3	·23	·25	·24	·4	·15	·06

In parts per 100,000

Probably combined as :—	A	B	C	D	E	F
Calcium carbonate ...	1·4	1·4	1·25	1·75	1·75	2·2
Magnesium carbonate ...	·95	1·05	·85	1·05	1·05	·93
Sodium carbonate ...	26·95	26·6	27·55	26·5	24·	25·84
Sodium sulphate ...	8·3	8·	8·	8·3	7·65	8·1
Sodium chloride ...	41·75	42·75	42·9	43·4	48·85	49·4
Sodium nitrate	·3	·35	·35	·55	·2	·08
Silica, &c.	1·35	1·35	1·1	2·45	1·5	·25
Total solid constituents dried at 180° C.	81·	81·5	82·	84·	85·	86·8
Hardness: Temporary ...	3°	4·5°	—	3°	—	—
Permanent ...	1·5°	1·5°	—	1°	—	—
Total ...	4·5°	6°	6°	4°	4·5°	4·8
Free ammonia	·05	·053	·044	0	·052	·07
Organic ammonia	·000	·000	·001	·002	·004	·001
Oxygen consumed in 3 hours at 37° C. ...	·025	·015	·022	·056	·012	·032
Nitrites	nil	nil	nil	nil	traces	nil

A.—No turbidity. Clear. Bright and free from colour.
F.—Very clear. Almost colourless. No odour.
Note the gradual and continuous increase in the amount of Sodium Chloride.

Leyton.

A.—West Ham Workhouse. See p. 211. 1st January, 1910.

B.—West Ham Infirmary, Whipscross Road. See p. 211. 1st January, 1910.

By Dr. J. C. THRESH.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	5·1	5·6	Calcium carbonate	12·7	14·
Mg.	2·2	1·4	Magnesium carbonate ...	6·2	4·8
Na.	4·96	4·76	Magnesium sulphate ...	2·	—
CO_3	12·	12·7	Sodium carbonate	—	1·6
SO_4	7·5	4·8	Sodium sulphate	8·7	7·1
Cl.	3·3	2·7	Sodium chloride	5·4	4·4
NO_3	·17	·17	Sodium nitrate	·23	·23
			Silica, &c.	·77	·87
			Total solid constituents dried at 180° C.	36·	33·

		A	B
Hardness :	Temporary ...	17·9°	17·9°
	Permanent ...	4·8°	2·8°
	Total ...	22·7°	20·7°

	A	B
Free ammonia	·02	—
Organic ammonia	·001	—
Oxygen absorbed in 3 hours at 37° C.	·03	—
Nitrites	nil	—

Littlebury.

? For Saffron Walden Rural District Council (124 ft. deep).

(No. 3, p. 213.) June, 1898.

By Dr. J. C. THRESH.

In parts per 100,000

		Probably combined as :—	
Ca.	11·1	Calcium carbonate ...	26·3
Mg.	·2	Calcium sulphate... ...	2·05
Na.	1·6	Magnesium chloride ...	·8
CO_3	15·8	Sodium chloride	2
SO_4	1·4	Sodium nitrate	2·95
Cl.	1·8	Alumina, silica, &c. ...	3·4
NO_3	2·15	Total solid constituents dried at 180° C....	37·5

Hardness : Temporary, 24° ; Permanent, 4° ; Total, 28°.

Free ammonia	0
Organic ammonia	·002
Oxygen absorbed in 3 hours at 37° C.	·024
Nitrites	nil.

Clear and colourless.

Little Coggeshall, see **Coggeshall**, p. 376.

Little Easton.

Easton Lodge (well 380 ft. deep). See p. 214. 27th November, 1903.
By Dr. J. C. Thresh.

In parts per 100,000

Ca.	4·5	Probably combined as :—	
Mg.	1·8	Calcium carbonate ...	11·25
Na.	14·6	Magnesium carbonate ...	6·3
CO_3	18·3	Sodium carbonate ...	12·25
SO_4	5·5	Sodium sulphate	8·15
Cl.	10·2	Sodium chloride	16·85
NO_3	·04	Silica, &c.	1·2
		Total solid constituents dried at 180° C. ...	56

Hardness: Temporary, 21°; Permanent, 1°; Total, 22°.

Free ammonia	·036
Organic ammonia	·006
Oxygen absorbed in 3 hours at 37° C.	·028
Nitrites	nil.

Faintly turbid (a little vegetable debris and a minute trace of iron).

Little Thurrock.

Isolation Hospital. Orsett Rural District Council. Stifford Long Lane (well 84 ft. deep). See p. 217. April, 1898.
By Dr. J. C. Thresh.

In parts per 100,000

Ca.	9·1	Probably combined as :—	
Mg.	3·7	Calcium carbonate ...	18·
Na.	11·2	Calcium sulphate... ...	6·45
CO_3	10·8	Magnesium sulphate ...	18·5
SO_4	31·3	Sodium sulphate	17·7
Cl.	3·9	Sodium chloride	6·45
NO_3	7·8	Sodium nitrate	10·7
		Silica, &c.	·5
		Total solid constituents dried at 180° C. ...	78·3

Hardness: Temporary, 19°; Permanent, 24°; Total, 43°.

Free ammonia	0
Organic ammonia	·009
Oxygen absorbed in 3 hours at 37° C.	·24
Nitrites	nil.

Little Wigborough.

Old well on Copt Hall or Copthall Marsh. See p. 217.
By Dr. J. C. Thresh. 16th May, 1900.

In parts per 100,000

Ca.	2·	Probably combined as :—	
Mg.	2·8	Calcium carbonate	5·
Na.	87·6	Magnesium carbonate	9·8
CO_3	21·5	Sodium carbonate	20·3
SO_4	18	Sodium sulphate	26·6
Cl.	108	Sodium chloride	178·2
NO_3	0	Trace of iron, a little sedimentary matter, &c.	4·1
		Total solid constituents dried at 180° C....	244·

Maldon (Waterworks).

A.—Waterworks. Wantz Road well. See pp. 220, 221. 20th January, 1898.
B.— Same. 16th March, 1910. The water was found to be getting harder Water was found to be entering through the upper part of the brick lining.
C.—Same. 25th October, 1911. After repair of well.
D.—Waterworks. Spital Road well (old well, 5 ft. diameter, and boring). See p. 220. 20th January, 1898.
E.—Same. 16th March, 1900.
F.—Same. 25th October, 1911. After deepening.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	C	D	E	F
Ca.	·9	6·1	·9	·7	·8	1·
Mg.	·7	1·8	·6	·6	·45	·52
Na.	52·05	40·7	43·98	44·75	44·7	51·04
CO_3	24·	20·3	24·3	23·7	23·6	23·3
SO_4	6·5	12·8	7·3	10·2	9·9	5·2
Cl.	50·3	43·3	36·8	36·4	36·3	50·5
NO_3	·3	3·5	·18	·3	·35	·12

Probably combined as :—	A	B	C	D	E	F
Calcium carbonate ...	2·25	15·25	2·25	1·75	2·	2·5
Magnesium carbonate ...	2·45	6·3	2·07	2·1	1·6	1·8
Sodium carbonate ...	36·9	11·75	38·	37·4	37·45	36·3
Sodium sulphate ...	9·75	18·95	10·8	15·	14·65	7·7
Sodium chloride ...	83·	71·45	60·7	60·	59·9	83·12
Sodium nitrate	·4	4·8	·24	·4	·5	·16
Silica, &c.	·25	2·	·94	2·35	1·	·92
Total solid constituents dried at 180° C....	135·	130·5	115·	119·	117·1	132·5
Hardness: Temporary	—	19·°	—	—	4°	—
Permanent	—	5·°	—	—	0°	—
Total	—	24°	8°	4°	4°	—
Free ammonia	—	·012	·072	·01	·015	—
Organic ammonia	—	·01	·002	·002	·0044	—
Oxygen absorbed in 3 hours at 37° C.	—	·055	·036	—	·038	—
Nitrites	trace	nil	nil	—	nil	—

Maldon (various).

A.—By Dr. P. F. Frankland.

B.—By Dr. J. Whitmore. See pp. 220, 221.

C.—By Dr. J. C. Thresh. See pp. 219, 220.

In parts per 100,000

	A. Ballast-pit in the fork next railway-station, July, 1889. A spring.	B. Water Works Deep well.	C. Maldon Workhouse, 11th May, 1909.
Calcium carbonate	—	—	3·25
Magnesium carbonate	—	—	1·75
Sodium carbonate	—	—	36·5
Sodium sulphate	—	—	8·7
Sodium chloride	—	—	81·3
Sodium nitrate	0	—	—
Chlorine	13·1	36·71	49·3
Silica, &c.	—	—	2·2
Total solid matters	54·73	112·	dried at 180° C. 183·
Loss on incineration	—	1·49	—
Hardness: Temporary ...	10°	—	—
Permanent ...	7·1°	nil	—
Total	17·1°	3·7	5·6
Free ammonia	·011	·088	·132
Albuminoid or organic ammonia ...	·019	·0022	·003
Nitrites	—	—	nil
Nitrogen as nitrates and nitrites ...	—	·099	trace.
Oxygen required to oxidize organic matter	—	·031	·17

A.—Turbid. Palatable. *C.*—Turbid with fine sand.

Manuden.

Boring 200 ft. deep, 120 ft. in soft chalk.

By J. W. Knights.

In parts per 100,000

Total solid matters		41·43
Chlorides (as sodium chloride)		5·19
Phosphates		none.
Nitrates		none.
Free ammonia		·084
Albuminoid ammonia		·001
Oxygen absorbed by organic matter	In 15 minutes ...	·014
	In 4 hours	·039

Appearance in 2-ft. tube: turbid, reddish brown.

No smell when heated to 100° F.

Contains Oxide of Iron.

Margaretting.

By Dr. J. C. THRESH.

A.—Eweland Hall. Entrance of subsoil-water suspected and proved to be the case. See p. 222. March, 1902.

B.—Same as *A*, but pure water from bore-hole after long pumping 5th March, 1903.

C.—Well by main road near pond in the village. See p. 223. 1899.

In parts per 100,000

	A	B	C
Calcium carbonate	14·25	2·25	37·7
Calcium sulphate	—	—	42·5
Magnesium carbonate	4·2	·35	—
Magnesium sulphate...	—	—	81·5
Sodium carbonate	13·15	33·3	—
Sodium sulphate	15·25	20·1	10·5
Sodium chloride	22·45	39·3	68·2
Sodium nitrate (nitrates)	·3	—	8·6
Water of crystallisation	—	—	12·2
Silica, &c.	1·4	Trace of nitrates, &c. ·7	·8
Total solid constituents dried at 180° C.	71·	96·	262·
Hardness: Total	18°	3°	—
Free ammonia	·0064	·062	—
Organic ammonia	·0028	·0075	—
Oxygen absorbed in 3 hours at 37° C.	·074	·15	—
Nitrites	nil	nil	—

A.—Slightly turbid from presence of FeO.

C.—This water, notable for excess of Epsom Salts (magnesium sulphate), probably comes from a local sandy bed in the London Clay. It is too hard to be of use for any domestic purpose.

Mayland.

Nipecils Farm. New well (1907).

By Dr. J. C. THRESH. 20th October, 1907.

In parts per 100,000

		Probably combined as :—	
Ca.	1·1	Calcium carbonate ...	2·75
Mg.	·65	Magnesium carbonate ...	2·25
Na.	49·55	Sodium carbonate ...	38·45
CO_3	25·	Sodium sulphate	10·6
SO_4	7·2	Sodium chloride	74·5
Cl.	45·2	Sodium nitrate	·55
NO_3	·4	Etc.	·9

Total solid constituents dried at 180° C. ...	130·
Hardness	6°
Free ammonia	·02
Organic ammonia	·004
Oxygen absorbed in 3 hours at 37° C. ...	·019
Nitrites	nil.

Mistley.

1. Deep well into Chalk. On the property of Mr. R. Free. (Free and Rodwell's Malting.) See p. 225.

By F. Sutton. (1897 or earlier.)

	In parts per 100,000
Total solids in solution	66·9
Sulphuric anhydride	6·26
Chlorine	17·31
Nitrogen as nitrates	trace only.
Lime	4·48
Magnesia	3·65
Ammonia, free	·064
Ammonia, organic	·01
Organic carbon	·233
Organic nitrogen	·056
Oxygen required	·029

Hardness: Permanent 1·3°; Temporary 9·5°; Total 10·8°.

Colour, etc., satisfactory. Microscopic examination satisfactory.

In almost all respects satisfactory. Organic impurity very low. The free ammonia, though rather high, is of no practical consequence and is common to all deep springs. The only weak point is the salt, represented by the Chlorine.

2. Free's Maltings. On the quay (? the newer well). See p. 225.

By Dr. J. C. Thresh. June, 1898.

		Probably combined as :—	In parts per 100,000
Ca.	3·25	Calcium carbonate ...	8·15
Mg.	2·36	Magnesium carbonate ...	8·25
Na.	21·8	Sodium carbonate ...	8·65
CO_3	15·7	Sodium sulphate	10·95
SO_4	7·4	Sodium chloride	36·5
Cl.	22·1	Sodium nitrate	·4
NO_3	·3	Silica, &c.	1·1
		Total solid constituents dried at 180° C....	74·

Hardness: Temporary 8·5°; Permanent 5·5; Total 14°.

Free ammonia	·000
Organic ammonia	·0005
Oxygen absorbed in 3 hours at 37° C. ...	·056
Nitrites	nil.

3. Tendring Hundred Water Co. Two wells.

By Dr. J. C. Thresh.

A.—Old well. See p. 426. June, 1898.

B.—New well See p. 426. November, 1911.

Mistley, cont.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	4·3	3·2	Calcium carbonate	10·75	8·
Mg.	1·5	2·7	Magnesium carbonate ...	5·25	9·3
Na.	23·9	19·8	Sodium carbonate	11·1	8·5
CO_3	16·5	16·2	Sodium sulphate	10·95	8·9
SO_4	7·4	6·	Sodium chloride	38·95	33·6
Cl.	23·6	20·4	Sodium nitrate	·7	—
NO_3	·5	—	Silica, &c.	1·3	·7

	A	B
Total solid constituents dried at 180° C.	79·	69·
Hardness : Temporary ...	—	17·5°
Permanent ...	—	3·5°
Total ...	14°	21°
Free ammonia	·01	·002
Organic ammonia	·0	·003
Oxygen absorbed in 3 hours at 37° C.	·02	·142
Nitrite	nil	nil

B.—Clear. Slightly yellow. Odour tarry.

Mucking.

1. Muckingford (Linford) Waterworks. Now belonging to the South Essex Co. See pp. 226, 227.

By Messrs. Corbyn, Stacey and Co. (Before 1896.)

	In parts per 100,000
Total solid matter	34·29
Free ammonia	none.
Albuminoid ammonia ...	practically none.
Chlorine	2·71
Nitrates and nitrites	none.

Without perceptible odour, taste or colour. Perfectly bright and clear and nearly free from suspended matter.

Reaction faintly alkaline.

Microscopic examination showed only a few particles of dust.

A specific test for sewage gave negative result.

A first-class water.

2. The same. Later analyses. By J. C. Thresh.

A.—11th May, 1899. *B.*—May, 1900. *C.*—17th June, 1911.

In parts per 100,000

	A	B	C	Probably combined as :—	A	B	C
Ca.	8·8	8·2	7·9	Calcium carbonate	16·5	17·05	18·2
Mg.	·5	·75	·65	Calcium sulphate ...	5·	4·75	2·05
Na.	1·1	1·7	2·06	Calcium nitrate ...	3·15	—	—
CO_3	9·9	10·25	10·9	Magnesium sulphate	—	1·55	2·45
SO_4	3·5	4·6	3·4	Magnesium chloride	1·6	1·75	·59
Cl.	2·85	2·85	2·9	Sodium chloride ...	2·75	2·55	4·06
NO_3	2·4	1·9	1·24	Sodium nitrate ...	—	2·6	1·7
				Silica, &c.	·5	1·75	1·95

	A	B	C
Total solid constituents dried at 180° C.	29·5	32·	31·
Hardness : Temporary ...	16°	—	11·4°
Permanent ...	10·5°	—	10°
Total ...	26·5°	23·5°	21·4°
Free ammonia	·000	·000	·001
Organic ammonia	·001	·001	·004
Oxygen absorbed in 3 hours at 37° C.	—	·0196	·012
Nitrites	nil	nil	nil

B.—Clear and colourless.

C.—Very clear. Very slightly yellow. No odour.

Mundon.

By Dr. J. C. Thresh.

A.—Old well at Mundon Hall. May, 1909.
B.—New well in village. 1st May, 1909. When not completed. Very turbid with fine sandy clay. (North of Sparrowick cottages. Maldon Rural District Council. See pp. 227, 228.)
C.—The same, after completion. (325 ft. deep. 1910.) 5th June, 1910.

In parts per 100,000

	A	B	C
Calcium carbonate	3·65	3·	3·5
Magnesium carbonate	2·95	1·4	1·55
Sodium carbonate	34·5	37·1	44·4
Sodium sulphate	18·8	12·	9·8
Sodium chloride	71·9	62·	70·
Sodium nitrate	·35	No nitrates	·12
Silica, &c.	·85	·5	1·13
Total solid constituents dried at 180° C.	133·	116·	130·5
Hardness: Total	7°	6°	6·4°
Free ammonia	·002	·112	·085
Organic ammonia	·004	·002	·002
Oxygen absorbed in 3 hours at 37° C.	·04	·172	·075
Nitrites	nil	nil	nil

Nazeing.

A.—South Essex Water Board's trial-bore of 1900 at Netherhall Farm. In the Lea Valley. See pp. 252, 253. ?In the parish of Roydon. 4th May, 1900.
B.—South Essex Water Board's trial-bore of 1900, half a mile north of St. Leonards. See p. 229. 5th May, 1900.
C. St. Leonards (100 ft. deep, through London Clay to Chalk). See p. 230. 8th February.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	C
Ca.	7·4	4·75	7·3
Mg.	3·5	2·05	3·4
Fe.	Very minute trace.	—	—
Na.	4·6	5·45	53·45
CO_3	19·5	13·75	15·1
SO_4	5·3	5·1	95·2
Cl.	2·9	2·7	17·
NO_3	·35	·15	1·0

Probably combined as:—	A	B	C
Calcium carbonate ...	18·5	11·85	18·25
Magnesium carbonate	11·9	7·15	5·8
Magnesium sulphate	—	—	8·75
Sodium carbonate ...	—	2·75	—
Sodium sulphate ...	7·85	7·6	130·2
Sodium chloride ...	4·8	4·45	28·05
Sodium nitrate ...	·5	·2	1·45
Silica, &c.	·45	—	2·
Total solid constituents dried at 180° C.	44·	34·	194·5
Hardness: Temporary ...	—	—	17°
Permanent ...	—	—	10°
Total ...	—	—	27°
Free ammonia	—	—	·008
Organic ammonia	—	—	·006
Oxygen absorbed in 3 hours at 37° C.	—	—	·056
Nitrites	—	—	nil

C.—No turbidity. Clear and colourless. Note the unusual amount of sodium sulphate.

Newport.

1. Four analyses by J. W. KNIGHTS.

A.—Shortgrove. Bromley. From well 10 ft. deep in gravel. 1893.

B.—Shortgrove. Newport Lodge. From well 10 ft. deep in gravel. 1894.

C and *D.*—Springs in rear of Grammar School. 1887.

In parts per 100,000

	A	B	C	D
Total solid matter	38·57	54·29	41·43	40·
Chlorides expressed as sodium chloride	3·06	4·	3·2	3·06
Nitrogen in nitrates	2·14	·71	·071	·113
Phosphates	—	—	trace.	trace.
Free ammonia	·011	·001	·0	·0
Albuminoid ammonia	·005	·002	·001	·001
Oxygen absorbed by organic matter :—				
In 15 minutes ...	·032	·044	·0086	·011
In 4 hours	—	—	·02	·026
Appearance in two-foot tube ...	clear, pale blue.	clear, pale blue.	clear.	pale blue.
Smell when heated to 100° F. ...	none.	none.	none.	none.
Microscopic examination ...	no deposit	no deposit	—	—

2. Two analyses by Dr. J. C. THRESH.

E.—Boring (132 ft. deep) of 1897. For Saffron Walden Rural District Council. 14th June, 1898.

F.—Newport House (boring of 1898, 272 ft. deep). 19th October, 1912.

In parts per 100,000

	E	F
Ca.	13·1	13·5
Mg.	·6	·5
Na.	·46	·8
Iron & Alumina.	1·3	—
CO_3	18·75	19·2
SO_4	2·7	1·6
Cl.	1·5	1·9
NO_3	·25	1·5
Silica	·8	—

Probably combined as :—	E	F
Calcium carbonate	31·25	32·
Calcium sulphate	2·05	2·3
Magnesium sulphate	1·55	—
Magnesium chloride	1·2	2·
Sodium chloride	1·	·65
Sodium nitrate	·3	2·05
Alumina, ferric oxide, silica, &c. ...	2·65	2·
Total solid constituents dried at 180° C.	40·	41·
Hardness : Temporary ...	26°	23·1°
Permanent ...	4°	5·4
Total ...	30°	28·5°
Free ammonia	·000	·001
Organic ammonia	·000	·001
Oxygen absorbed in 3 hours at 37° C.	·024	·012
Nitrites	nil	nil

E.—Turbid from deposition of Iron.

F.—Clear and bright but deposited Iron Oxide on standing.

North Benfleet.

A.—Rectory well. See p. 232.

B.—Public pump about half a mile east of Rectory, on road-side. See p. 232. April, 1898.

By Dr. J. C. Thresh.

	A	B
	In parts per 100,000	
Calcium carbonate	25·65	·25
Magnesium carbonate	1·5	1·75
Magnesium sulphate	45·4	—
Sodium carbonate	—	27·35
Sodium sulphate	—	16·6
Sodium chloride	29·9	44·2
Sodium nitrate	·35	·2
Water of crystalisation	6·8	—
Silica, &c.	·4	3·15
Total solid constituents dried at 180° C.	110	93·5
Hardness: Temporary ...	—	3·5°
Permanent ...	—	1·5°
Total ...	+ 60°	5°
Free ammonia	·000	·06
Organic ammonia	·004	·003
Oxygen absorbed in 3 hours at 37° C. ...	·08	·084
Nitrites	nil	nil

Orsett.

Orsett Union (well sunk 1898). See p. 234. 20th February, 1900.

By Dr. J. C. Thresh.

In parts per 100,000

		Probably combined as :—	
Ca.	7·5		
Mg.	1·2	Calcium carbonate	18·75
Na.	1·65	Magnesium carbonate	1·05
K.	·55	Magnesium sulphate	4·25
Fe_2O_3	·8	Sodium chloride	4·25
CO_3	12	Potassium chloride	1·
SO_4	3·4	Ferric oxide	·8
Cl.	3·	Silica, &c. (a little suspended clay.	1·6
NO_3	·13	Traces of nitrates.)	
		Total solid constituents dried at 180° C. ...	31·7

Hardness: Temporary, 16°; Permanent, 8°; Total, 24°

Free ammonia	·011
Organic	·0
Oxygen absorbed in 3 hours at 37° C. ...	·041
Nitrites	nil.

Opalescent.

For an analysis of the water at Orsett Isolation Hospital, see Little Thurrock, p. 416.

Osea.

Mr. Carrington's House. Retreat for Inebriates. Boring of 1904.

By Dr. J. C. THRESH. 25th March, 1904.

In parts per 100,000

Ca.	3·15	Probably combined as :—	
Mg.	1·1	Calcium carbonate ...	7·9
Na.	35·65	Magnesium carbonate ...	3·85
CO_3	20·7	Sodium carbonate ...	23·35
SO_4	11·7	Sodium sulphate	17·3
Cl.	30·6	Sodium chloride	50·5
		Etc.	1·6
		Total solid constituents dried at 180° C. ...	104·5

Hardness : Temporary, 9°; Permanent, 1·5; Total, 10·5,

Free ammonia	·08
Organic ammonia	·012
Oxygen absorbed in 3 hours at 37° C. ...	·124
Nitrites	nil.

Ovington.

? Public well.

Made by J. W. W. KNIGHTS, County Analyst for Cambridgeshire. 1896.

Communicated by Mr. G. INGOLD.

In parts per 100,000

Total solid matter	110·
Chlorides, as common salt...	20·2
Free ammonia	·041
Albuminoid ammonia	·003
Nitrates	none
Some iron	
Oxygen absorbed in 15 minutes at 140° F.	·056

Microscopic Examination.—Deposit of Oxide of Iron.

Peldon.

Peldon Lodge. Boring 550 ft. deep. In Chalk. See p. 235.

By Dr. J. C. THRESH. February, 1907.

In parts per 100,000

Ca.	1·5	Probably combined as :—	
Mg.	1·4	Calcium carbonate ...	3·75
Na.	65·55	Magnesium carbonate ...	4·9
CO_3	23·8	Sodium carbonate ...	31·95
SO_4	11·5	Sodium sulphate	17·
Cl.	71·	Sodium chloride	117·15
NO_3	0	Silica, &c.	·75
		Total solid constituents dried at 180° C....	175·5

Pitsea.

A.—Pitsea pumping station. Southend Water Co. Really in Vange. See p. 386. 14th January, 1909.
B.—British Explosives Syndicate (855 ft. deep). See pp. 236, 237. 12th January, 1901.
C.—The same. 29th June, 1911.
D.—Public well beside main road on the boundary of Bowers Gifford. See p. 237. April, 1898.

By Dr. J. C. Thresh.

	A	B	C	D
Ca.	·7	·8	·72	1·3
Mg.	·3	·3	0	1·05
Na.	28·6	27·7	28·92	—
CO_3	17·6	15·3	17·24	18·
SO_4	9·3	9·8	2·82	13·
Cl.	18·3	19·7	23·3	22·5
NO_3	·15	·2	·06	·26

In parts per 100,000

Probably combined as :—	A	B	C	D
Calcium carbonate	1·75	2·	1·8	3·25
Magnesium carbonate	1·05	1·05	0	3·65
Sodium carbonate	27·8	23·55	28·59	25·65
Sodium sulphate	13·8	14·5	4·16	19·25
Sodium chloride	30·2	32·5	38·43	37·1
Sodium nitrate	·25	1·4	·08	·35
			trace of iron	
Silica, &c.	1·65		·94	·75
Total solid constituents dried at 180° C. ...	76·5	75·	74·	88·
Hardness : Temporary	—	3°	—	6·5°
Permanent	—	1·5°	—	1·5°
Total	4·3°	4·5°	2·5°	8°
Free ammonia	·068	·008	·045	·000
Organic ammonia	·000	·004	·0045	·003
Oxygen absorbed in 4 hours at 27° C.	·032	·304	·085	·08
Nitrites	nil	nil	nil	nil

B.—Of excellent quality. *C.*—Dull. Yellowish grey. Very slight odour.

Pitsea.

Southend Water Co., Nevendon well. See p. 238. 1907.
Dr. J. C. Thresh.

A.—27th December, 1907. *B.*—14th January, 1909. *C.*—11th May, 1910. *D.*—9th January, 1912. Water from Tertiaries. *E.*—Water from boring into chalk, August, 1914. *F.*—1915.

	A	B	C	D	F
Ca.	·7	·85	1·	·62	·62
Mg.	·4	·3	·3	·3	·3
Na.	32·6	32·25	34·36	33·5	33·2
CO_3	18·3	18·2	18·7	18·	17·6
SO_4	9·35	8·9	10·6	11·	5·4
Cl.	23·9	23·7	25·6	24·	27·4
NO_3	·4	·15	·17	·14	·0

In parts per 100,000

Probably combined as :—	A	B	C	D	E	F
Calcium carbonate	1·75	2·15	2·5	1·55	1·85	1·55
Magnesium carbonate	1·4	1·05	1·	1·05	·7	1·
Sodium carbonate	28·7	28·6	29·2	28·89	29·7	29·47
Sodium sulphate	13·85	13·2	15·6	16·28	9·2	8·
Sodium chloride	39·4	39·1	42·2	39·6	43·9	45·2
Sodium (some potassium) nitrate ...	·55	·25	·2	·19	—	—
Etc.	·9	·65	·8	1·44	1·65	·78
Total solid constituents dried at 180° C. ...	86·5	85·	91·5	89·	87·	85·
Hardness: Temporary ...	—	—	—	3°	—	2°
Permanent ...	—	—	—	0	—	0
Total ...	5°	4°	4°	3°	2·5°	2°
Free ammonia	·08	·068	·058	·0064	—	·038
Organic ammonia	·000	·001	·002	·0008	—	·002
Oxygen absorbed in 3 hours at 37° C.	·028	·024	·044	0	—	·03
Nitrites	nil	nil	nil	nil	—	nil

C.—Very clear. Very slight yellow colour. No odour. *F.*—A little yellow sand. Colour faint yellow-green. No odour.

The analyses show on the whole a gradual increase in sodium-chloride.

Prittlewell (should have been entered under **Southend**).

Southend Waterworks. See p. 263.

From Dr. THRESH'S Report to the Local Board on Typhoid at Southend. 1890.

By Dr. TIDY. February, 1888.

	In parts per 100,000
Total solid matter	95·77
Ammonia	·0129
Nitrogen in nitrates and nitrites	·179
(= nitric acid)	(·803)
Oxygen required to oxidise organic matter	none.
Organic carbon	·034
Organic nitrogen	·029
Lime (CaO)	2·19
Magnesia (MgO)	trace.
Sulphuric anhydride (SO_3)	11·89
Chlorine (=common salt 44·8)	39·01
Silica	1·23
Hardness, before boiling	3·11
,, after boiling	·17

Clear, colourless.

From the same Report. By Dr. J. C. THRESH. October, 1890.

	In parts per 100,000
Total solids (effect on ignition—nil) ...	104·29
Phosphates	none.
Nitric nitrogen	·1
Chlorine	33·57
Alkalinity	26·71
Hardness	3·57
Lead and Iron	none.
Free ammonia	·94
Organic ammonia	·021
Nitrous nitrogen	·0
Oxygen used in 3 hours	·3

Clear and colourless.

Microscopic Examination.—No vegetable or animal life. No signs of pollution.

(He states in the Report that he finds no reason to attribute the Typhoid to the water-supply.)

By Dr. J. C. THRESH. 28th December, 1908.

			In parts per 100,000
Ca.	·7	Probably combined as :—	
Mg.	·35	Calcium carbonate ...	1·75
Na.	35·15	Magnesium carbonate ...	1·25
CO_3	15·2	Sodium carbonate ...	23·5
SO_4	5·35	Sodium sulphate	7·9
Cl.	33·7	Sodium chloride	56·
NO_3	·15	Sodium nitrate	·2
		Silica, &c.	1·4
		Total solid constituents dried at 180° C. ...	92·
		Hardness : Total	5°
		Free ammonia	·04
		Organic ammonia	·004
		Oxygen absorbed in 4 hours at 27° C.	·032
		Nitrites	small trace.

Quendon.

A.—Laundry (Quendon Hall), northern end of village, near the inn (148 ft. deep). See p. 240. March, 1911.

B.—Quendon Hall (172 ft. deep). See p. 239. 23rd May, 1908.

C.—Quendon boring of South Essex Water Trust. See p. 240. 7th May, 1900.

By Dr. J. C. THRESH.

In parts per 100,000

	A	B	C
Ca.	11·6	11·25	12·7
Mg.	·35	·25	·2
K.	—	·95	—
Na.	·8	·35	·4
Fe.	·05	—	—
CO_3	15·6	15·7	13·9
SO_4	1·1	1·4	5·3
Cl.	1·6	1·6	2·
NO_3	3·5	1·5	2·

Probably combined as :—	A	B	C
Calcium carbonate	26·	26·15	23·2
Calcium sulphate ...	1·55	2·	7·5
Calcium chloride ...	2·05	·55	3·1
Magnesium chloride	·4	·95	—
Magnesium nitrate	1·55	—	1·2
Sodium chloride ...	—	·9	—
Sodium nitrate ...	3·	—	1·4
Potassium nitrate ...	—	2·45	—
Silica, &c.	1·25	·3	·6
Total solid constituents dried at 180° C.	35·8	33·3	37·
Hardness : Temporary	21°	—	—
Permanent	6°	—	—
Total	27°	24°	—
Free ammonia	·0006	·0004	—
Organic ammonia	·0012	·001	—
Oxygen absorbed in 3 hours at 37° C.	·017	—	—
Nitrites	nil	nil	—

A.—White, opalescent. Sediment of Chalk and Iron Oxide. No odour. Reaction neutral.

Radwinter.

The Grange Farm. Deep well. See p. 241. 27th November, 1912.

By Dr. J. C. THRESH.

In parts per 100,000

Ca.	11·1
Mg.	·6
Na.	1·7
CO_3	15·9
SO_4	5·2
Cl.	1·6
NO_3	0·

Probably combined as :—	
Calcium carbonate ...	26·5
Calcium sulphate... ...	1·7
Magnesium sulphate ...	3·
Sodium sulphate	2·3
Sodium chloride	2·6
Sodium nitrate	0·
Silica, &c.	·4
Total solid constituents dried at 180° C.... ...	36·5

Hardness : Temporary, 26° ; Permanent, 6° ; Total, 32°

Free ammonia	·001
Organic ammonia	·003
Oxygen absorbed in 3 hours at 37° C. ...	·124
Nitrites	·0

Turbid (due to Iron Oxide). Brownish. No odour. Reaction very faintly acid.

Rainham.

Creek Mouth. Messrs. Wickens, Pease and Co.

A.—No. 1 well. See p. 241. 7th April, 1910.

B.—No. 3 well (Chalk just reached). See p. 242. March, 1910.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	17·8	22·5	Calcium carbonate	24·3	25·5
Mg.	4·7	7·7	Calcium sulphate	23·	23·9
Na.	42·23	47·5	Calcium chloride	3·82	14·7
CO_3	14·6	15·3	Magnesium chloride ...	18·3	30·1
SO_4	16·3	16·9	Sodium chloride	107·	120·7
*Cl.	81·	105·	Sodium nitrate	·48	—
NO_3	·35	—	Silica, &c.	3·1	2·1
			Total solid constituents dried at 180° C.	180·	217·
			Hardness : Total	70°	over 50°
			Free ammonia	·059	·14
			Organic ammonia	·0	·003
			Oxygen absorbed in 3 hours at 37° C.	·054	·06
			Nitrites	nil	nil

* The analysis of *B* previous to this is said to have given a lower figure for Chlorides, viz., 133·7 as Sodium Chloride = 81·1 of Chlorine. *A* was then 10 to 20 grains per gallon lower in Chlorine (reckoned as Sodium Chloride) than *B* was. So the Cl.-figure for *A* must previously have been lower than 81.

A.—Colour, yellow. Cloudy deposit. No odour.

B.—Yellow. Dull and cloudy. No odour.

Romford.

1. Breton's Farmhouse. From the *Sixth Rep. Riv. Poll. Comm.*, 1874, p. 86. 9th November, 1871.

In parts per 100,000

Total solid impurity	107·6
Organic carbon	·671
Organic nitrogen	·158
Ammonia	·057
Nitrogen as nitrates and nitrites	3·826
Total combined nitrogen	4·031
*Previous sewage or animal contamination	38,410·
Chlorine	11·6

Hardness : Temporary, 28·6 ; Permanent, 28·5 ; Total, 57·1.

Clear.

* For explanation of previous sewage contamination, see **Colchester,** p. 348.

One of several samples from shallow wells in gravel on London Clay, which, though yielding clear and palatable water are horribly polluted and "are, as a rule . . supplied chiefly by infiltration from sewers and cesspools." As the water is not suitable for washing and is dangerous to health if used for drinking, "these wells ought, with one or two exceptions, to be closed without delay." [There is nothing in the Report to indicate that this water should be an exception, and it appears to be about the average of the series, in some respects below it.]

Romford, cont.

2. Various deep wells.

A.—Romford well. South Essex Water Co. See pp. 248, 249. 11th April, 1899.

B.—Same. 12th December, 1900.

C.—Ind, Coope and Co.'s Brewery (well 450 ft. deep and in Chalk). See p. 249. 15th December, 1900.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	C	Probably combined as :—	A	B	C
Ca.	5·3	—	6·25				
Mg.	3·55	—	3·5	Calcium carbonate	13·25	—	15·65
Na.	5·65	—	9·85	Magnesium carbonate	10·15	—	10·9
CO_3	15·2	—	17·2	Magnesium sulphate	3·25	—	2·
SO_4	5·7	—	10·9	Sodium sulphate ...	4·6	—	13·75
Cl.	6·15	—	8·2	Sodium chloride ...	10·15	—	13·5
NO_3	·45	minute trace.	·3	Sodium nitrate ...	·6	—	·4
				Silica, &c.	1·	—	·8

		A	B	C
Total solid constituents dried at 180° C. ...		43·	48·	57·
Hardness :	Temporary	14°	—	17°
	Permanent ...	14°	—	10°
	Total ...	28°	30°	27°
Free ammonia		·001	·08	·096
Organic ammonia		·005	·005	·003
Oxygen absorbed in 3 hours at 37° C. ...		·017	·006	·032
Nitrites		nil	nil	nil

A.—No turbidity. Clear and colourless.

B.—No turbidity. Clear, bright, faintly yellow.

Rowhedge.

A.—Messrs. Daniell's. East Donyland Steam Brewery. Deep well into Chalk. See p. 250. By R. T. Daniell. (Previous to 1883.)

B.—Heath House. Well 267 ft. deep, into Chalk. See pp. 249, 250.

By Dr. J. C. Thresh. 11th February, 1901.

In parts per 100,000

		A	B
Sodium chloride		80·	116·3
Magnesium carbonate		6·96	7·85
Calcium carbonate		4·84	5·25
Sodium carbonate		21·2	17·25
Sodium sulphate		9·04	13·6
Sodium nitrate		—	·7
Silica		trace.	(&c.) ·55
Organic matter and loss on analysis		1·53	—
Total solids		123·57	161·5
Free ammonia		·088	·092
Albuminoid ammonia		·01	·005
Nitrites		—	nil
Hardness :	Permanent	6°	4·3°
	Temporary	6°	8·7°
	Total	12°	13°

Roxwell.

Skreen's Park (boring 458 ft., in Chalk). See p. 251. 13th May, 1909.

By Dr. J. C. THRESH.

In parts per 100,000

Ca.	·8	Probably combined as :—	
Mg.	·25	Calcium carbonate	2
Na.	29·6	Magnesium carbonate	85
CO_3	19·2	Sodium carbonate	30·8
SO_4	11·5	Sodium sulphate	17·
Cl.	16·4	Sodium chloride	27·1
NO_3	0·	Traces silica, ferruginous clay, &c.	2·25
		Total solid constituents dried at 180° C. ...	80·
		Hardness : Total	3·5°
		Free ammonia	·052
		Organic ammonia	·006
		Oxygen absorbed in 3 hours at 37° C. ...	·32*

* Water very turbid with sand and ferruginous clay difficult to remove. Hence (ferruginous clay) the high figure for oxygen absorbed.

Roydon.

Trial-boring near Roydon station for South Essex Water Board (101 ft. deep, 1900). See p. 252. Taken when bore was tubed to 61½ ft. and after many hours pumping (therefore from Chalk).

By Dr. J. C. THRESH. May, 1900.

In parts per 100,000

Ca.	13·7	Probably combined as :—	
Mg.	·6	Calcium carbonate ...	34·25
Fe.	·6	Ferrous carbonate ...	1·2
Na.	1·8	Magnesium sulphate ...	2·8
CO_3	21·	Sodium chloride	3·8
SO_4	2·2	Sodium nitrate	1·2
Cl.	2·3	Silica, &c.	1·15
NO_3	·9		
		Total solid constituents dried at 180° C....	44·4
		Hardness : Total	31°
		Free ammonia	·08
		Organic ammonia	·005
		*Oxygen absorbed in 3 hours at 37° C. ...	·12
		Nitrites	nil.

* A little oxygen absorbed by the Iron present.

Clear when taken. Became very turbid by next morning from deposition of Oxy-carbonate of Iron.

See also under **Nazeing**.

Saffron Walden.

Waterworks.

A.—Well of 1836 (1,004 ft. deep). See pp. 253, 254. 13th March, 1900.

B.—New well. See p. 254. March, 1910.
1898. See p.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as :—		
Ca.	14·7	13·9	Calcium carbonate ...	26·	26·8
Mg.	·6	·42	Calcium sulphate ...	7·65	5·1
Na.	2·6	1·45	Calcium chloride ...	5·65	4·7
CO_3	15·6	16·1	Magnesium chloride ...	·4	·54
SO_4	5·4	3·6	Magnesium nitrate ...	3·1	1·68
Cl.	3·9	3·4	Sodium nitrate ...	9·7	5·35
NO_3	9·7	5·3	Silica, &c.	·8	1·33
			Total solid constituents dried at 180° C.	53·3	45·5
			Hardness : Temporary	22°	19°
			Permanent	12°	8°
			Total	34°	27°
			Free ammonia	·000	·001
			Organic ammonia	·006	·003
			Oxygen absorbed in 3 hours at 37° C.	·015	·024
			Nitrites	nil	nil

A.—Bright. Clear and colourless.

B.—Clear. Almost colourless. No odour.

St. Osyth.

Mr. Newcomb's well. Mill Street. See p. 255.

By Dr. J. C. Thresh. 3rd October, 1910.

In parts per 100,000

		Probably combined as :—	
Ca.	7·8	Calcium carbonate ...	19·5
Mg.	1·2	Magnesium carbonate ...	4·1
Na.	27·1	Sodium carbonate ...	12·
CO_3	21·3	Sodium sulphate	34·2
SO_4	23·1	Sodium chloride	24·8
Cl.	15·	Sodium nitrate	3·4
NO_3	2·5	Etc.	1·
		Total solid constituents dried at 180° C....	99·
		Hardness : Temporary ...	19°
		Permanent ...	2°
		Total	21°
		Free ammonia	·000
		Organic ammonia	·007
		Oxygen absorbed in 3 hours at 37° C.	·100
		Nitrites	nil.

Shoeburyness.

1. Garrison or South Shoebury boring. Less than half a mile north-east of St. Andrew's Church, see pp. 258, 259.

Sample taken December, 1888, when boring was 844 ft. deep [in Chalk]. Analysed January, 1889.

By Prof. J. L. Notter.

Qualitative Examination (so far as not given below).

Magnesia, trace. Sulphuric Acid, large. Oxidisable matter, trace

Quantitative Examination. In parts per 100,000.

Volatile matter ...	10·
Chlorine ...	26·5
Calcium carbonate ...	·6666
Fixed hard salts ...	4·
Sulphuric Acid (SO_4) ... Alkaline carbonates ... Sodium or other metal (combined with Cl. or SO_4, not included in fixed hard salts) ... Silica, alumina, iron, &c. ...	58·8334
Total solids by evaporation ...	100·

Oxygen required for organic matter ...		·128
These with the oxidisable organic matter are included in the volatile matter :—	Free ammonia ...	·0453
	Albuminoid ammonia...	·0052
	Nitric acid ...	·313
	Nitrous acid ...	0
	Total nitrogen in nitrites and nitrates	·3003

Hardness in parts per 100,000: Permanent, 4; Temporary, 1; Total, 5.

Microscopic Examination.

Amorphous granular mineral matter and a few minute infusoria.

Bacteria Experiments.

Liquefaction after 6 days: very extensive after 9 days, increasing slowly

Physical Characters.

Slightly yellow, turbid (sediment very large), dull. Taste, nauseous. No smell.

Remarks.

Contains an excess of Chlorine, of total solids and of Free Ammonia. The small amount of hardness is against its being contaminated by sea-water. The organic matter is due possibly to the Nitrogenous matter in the strata, and if so is harmless.

The water may be used for drinking purposes after filtration.

See also the following :—

2. Three analyses. By Dr. J. C. Thresh

A.—Garrison well (1,048 ft. deep). See p. 258. 8th April, 1910.

B.—Public supply from Shoebury pumping-station. See p. 257. 1st March, 1912.

C.—Public supply from the well of 1897 (475 ft. deep). See p. 257. July, 1898.

A.—Clear. Very faint yellow. No odour.

B.—Slightly dull (a little fine white sand in suspension). Faint yellowish colour. No odour.

Shoeburyness, cont.

In parts per 100,000

	A	B	C	Probably combined as :—	A	B	C
Ca.	·94	·85	1·6	Calcium carbonate	2·34	2·12	4·
Mg.	·7	·3	·25	Magnesium carbonate	2·4	1·03	·85
Na.	34·85	36·3	35·6	Sodium carbonate ..	24·9	26·9	24·05
Fe.	—	—	trace.	Sodium sulphate ...	8·29	8·7	10·35
CO_3	17·2	17·2	16·6	Sodium chloride ...	54·1	55·1	55·3
SO_4	5·6	5·9	7·	Sodium nitrate ...	·23	·4	·0
Cl.	32·8	33·4	33·5	Silica, &c.	1·24	·25	·45
NO_3	·17	·3	·0				
				Total solid constituents dried at 180° C.	93·5	94·5	95·
				Hardness: Temporary ...	3·6°	4°	4°
				Permanent ...	2·1	0	0
				Total ...	5·7°	4°	4°
				Free ammonia	·032	·045	·06
				Organic ammonia	·001	·001	·002
				Oxygen absorbed in 3 hours at 37° C.	·016	·035	·16*
				Nitrites	slight trace.	·0	minute trace.

* The high figure due to traces of FeO and Nitrites.

South Benfleet.

A.—Well and boring (612 ft. deep, unfinished). Southend Waterworks. Originally for Rochford Rural District Council. See p. 260. 27th October, 1900.

B.—Same. 10th February, 1912.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	·8	·85	Calcium carbonate	2·	2·15
Mg.	·3	·26	Magnesium carbonate ...	1·05	·9
Na.	33·54	33·71	Sodium carbonate	26·85	27·7
CO_3	17·2	17·6	Sodium sulphate	12·9	11·84
SO_4	8·7	8·	Sodium chloride	44·7	45·2
Cl.	27·1	27·4	Sodium nitrate	·5	·13
NO_3	*·36	·1	Etc.	1·	·58
			Total solid constituents dried at 180° C.	89·	88·5
			Hardness: Temporary ...	4°	—
			Permanent ...	—	—
			Total ...	4°	4°
			Free ammonia	·056	·025
			Organic ammonia	·005	·002
			Oxygen absorbed in 3 hours at 37° C.	·048	·042
			Nitrites	·0	slight trace.

* A later sample of *A* (20th November, 1900) gave almost exactly similar mineral results, except that the Nitrates (NO_3) had disappeared entirely.

A.—Faintly turbid, possibly owing to the work of sinking.

Southend.

Southchurch pumping-station of the Southend Water Co. See pp. 263, 264.
By Dr. J. C. Thresh. 28th December, 1908.

In parts per 100,000

Ca.	·5	Probably combined as :—	
Mg.	·25	Calcium carbonate	1·25
Na.	34·6	Magnesium carbonate	·85
CO_3	17·2	Sodium carbonate	28·
SO_4	5·	Sodium sulphate	7·4
Cl.	30·7	Sodium chloride	50·65
NO_3	·2	Sodium nitrate	·3
		Silica, &c.	1·55
		Total solid constituents dried at 180° C....	90·
		Hardness : Total ...	4·3°

Free ammonia	·024
Organic ammonia	·001
Oxygen absorbed in 4 hours at 27° C.	·028
Nitrites	traces.

Shallow pump-well at new sewage-works. (1912.)
By Dr. J. C. Thresh. 10th July, 1912.

In parts per 100,000

Ca.	13·2	Probably combined as :—	
Mg.	1·6	Calcium carbonate	33·
Na.	10·9	Magnesium carbonate	3·1
CO_3	22·	Magnesium sulphate	3·4
SO_4	11·5	Sodium sulphate	13·
Cl.	7·1	Sodium chloride	11·7
NO_3	5·7	Sodium nitrate	7·8
		Silica, &c.	·5
		Total solid constituents dried at 180° C....	72·5

Hardness : Temporary, 19; Permanent, 18; Total, 37.

Free ammonia	·001
Organic ammonia	·006
Oxygen absorbed in 3 hours at 37° C.	·028
Nitrites	nil.

Clear and bright. Faintly green. No odour. Reaction neutral.

Waterworks. (Southend well.) See pp. 261, 262.
From Dr. Thresh's Report to the Local Board on Typhoid at Southend, 1890.
By Dr. Tidy. March, 1880.

In parts per 100,000

Total solid matter	91·79
Ammonia	·0014
Nitrogen in nitrates and nitrites	·129
(=Nitric acid)	(·579)
Oxygen required to oxidise organic matter ...	·0214
Organic carbon	·087
Organic nitrogen	·029
Lime (CaO)	2·1
Magnesia (MgO)	·72
Sulphuric anhydride (SO_3.)	6·39
Chlorine (=common salt 51·02)	32·5
Hardness, before boiling, 1·6; after boiling ...	4
Silica	1·7

Southend, cont.

From the same Report.

By Dr. J. C. THRESH. October, 1890.

	In parts per 100,000
Total solids	95·
Effect of ignition	nil.
Phosphates	none.
Nitric nitrogen	·071
Chlorine	33·14
Alkalinity	26·43
Hardness	4·29
Lead and iron	·0
Free ammonia	·048
Organic ammonia	·001
Nitrous nitrogen	·009
Oxygen used in 3 hours	·02
Oxygen in solution ...	·3 (·23 after keeping 12 days)

Faintly turbid.

Microscopic Examination. No vegetable or animal life. A little calcareous and siliceous matter in suspension. No signs of pollution.

(He states in the Report that he finds no reason to attribute the Typhoid to the water-supply.)

Waterworks. (Southend well).

By Dr. J. C. THRESH. 28th December, 1908.

		Probably combined as :—	In parts per 100,000
Ca.	·75 ...	Calcium carbonate ...	1·85
Mg.	·35 ...	Magnesium carbonate ...	1·2
Na.	34·3 ...	Sodium carbonate ...	22·7
CO_3	14·8 ...	Sodium sulphate	8·9
SO_4	6· ...	Sodium chloride	54·7
Cl.	33·2 ...	Sodium nitrate	·2
NO_3	·15 ...	Silica, &c.	1·45
		Total solid constituents dried at 180° C.	91·
		Hardness: Total	3·5°
		Free ammonia	·036
		Organic ammonia	·003
		Oxygen absorbed in 4 hours at 27° C.	·016
		Nitrites	small trace.

It is of interest to turn to an old analysis of the water of the Southend well, as given by G. W. WIGNER in The Water Supply of Sea-side Watering Places, 1878, p. 21:—

	In parts per 100,000
Total solid matter	97·43
Loss on ignition after deducting combined carbonic acid ...	6·56
Lead and copper	none.
Iron	slight traces.
Chlorine, calculated as sodium-chloride	54·49
Hardness before boiling, Clark's test, 1·6°; after boiling ·2°	
Nitrogen as ammonia	·0166
,, albuminoid ammonia	·0039
,, nitrates	·8
,, nitrites	·029
Total nitrogen in the four forms	·849
Oxygen absorbed by organic matter	·057

Smell and colour satisfactory. Taste saline. Microscopic appearance satisfactory.

Southend, cont.

Special Report, Dr. J. T. C. Nash, M.O.H., September, 1901.

The water-supply, consisting of a mixture from all sources in use, was complained of by several people on 2nd September, 1901, as containing living animalculae (later found to be *Daphnia*).

These were suspected to come from the reservoir at Thundersley (then new) and this part of the supply was cut off and the reservoir emptied and examined.

On September 3rd three samples of the supply were collected from various parts of the town and submitted for analysis, etc., to Dr. B. Dyer, who reported that chemically they were normal, but that the water was slightly yellow and that "The bacteriological condition of this water is unsatisfactory, and more resembles that of surface water than deep well water." This remark applied to two samples marked Newark House, 109, London Road, and Hatfield House, Victoria Avenue. Of the third, marked St. Kit's, Anerley Road, he said, "The bacteriological condition . . is decidedly less good than usual."

Later, two samples taken on 16th September, 1901, from Anerley Road and Victoria Avenue, and reported on by Dr. Dyer, gave very much better bacteriologic results than two of the three samples of September 3rd, and were distinctly better than the third. They could not, however, be regarded as satisfactory.

The explanation advanced by Dr. Nash was that the Thundersley Reservoir being uncovered, the animalculae (*Daphnia*) were brought by birds, the bacteria being also accountable to the excreta of the birds and of the animalculae.

The Report contains a table of bacteriologic results from 16th February, 1899, to 16th September, 1901, and the chemical analyses made at the time of the unsatisfactory conditions. For notes on the bacteriologic results see pp. 62, 63.

The reservoir has since been covered in.

South Fambridge.

Well and boring 50 yds. east of post-office. (Ironworks.) See p. 265.

By Dr. J. C. Thresh. 6th April, 1900.

			In parts per 100,000
Ca.	·65	Probably combined as :—	
Mg.	·35	Calcium carbonate ...	1·65
Na.	39·7	Magnesium carbonate ...	1·25
CO_3	21·5	Sodium carbonate ...	34·7
SO_4	7·	Sodium sulphate	10·35
Cl.	32·4	Sodium chloride	53·45
NO_3	·5	Sodium nitrate	1·1
		Total solid constituents dried at 180° C....	102·5
		Hardness: Total ...	3°
		Free ammonia	·009
		Organic ammonia ...	·006
		Nitrites	nil.

South Hanningfield.

Brockley (? Brock) Hill. Shallow well in Boulder Clay.

By Dr. J. C. THRESH. November, 1898.

In parts per 100,000

Ca.	19·6	Probably combined as :—	
Mg.	2·9	Calcium carbonate ...	23·4
Na.	9·7	Calcium sulphate... ...	17·6
K.	1·4	Calcium chloride	14·1
CO_3	14·1	Magnesium chloride ...	11·5
SO_4	12·4	Sodium chloride	24·6
Cl.	32·5	Potassium nitrate ...	3·7
NO_3	2·25	Silica, &c.	3·1
		Total solid constituents dried at 180° C.	98·

Hardness: Temporary, 23°; Permanent, 23°; Total, 46°.

Free ammonia	·004
Organic ammonia	·014
Oxygen absorbed in 3 hours at 37° C.	·24
Nitrites	nil.

Southminster.

1. Deal Hall, Southminster Marshes. Well of 1906 (said to end in Thanet Sand).

1. Deal Hall, Southminster Marshes.
Well of 1906 (said to end in Thanet Sand).

In parts per 100,000

Ca.	1·2	Probably combined as :—	
Mg.	·4	Calcium carbonate ...	3·
Na.	51·	Magnesium carbonate ...	1·4
CO_3	22·4	Sodium carbonate ...	34·6
SO_4	6·9	Sodium sulphate	9·8
Cl.	50·9	Sodium chloride	84·
NO_3	·25	Traces of nitrates, &c. ...	1·3
		Total solid constituents dried at 180° C.	134·1
		Hardness: Total ...	6°

Free ammonia	·08
Organic ammonia	·003
Oxygen absorbed in 3 hours at 37° C.	·04
Nitrites	nil.

2. Public pump (before 1890).

In parts per 100,000

Chlorine as chlorides	3·1
Nitrogen as nitrates	1·68
Total solids	44·
Hardness before boiling	17°
Saline ammonia	·001
Organic ammonia	·01
Oxygen required to oxidise organic matter ...	·07

Stanford-le-Hope.

A.—Brewery. Close to the railway-station. See p. 268. June, 1898.
B.—Broad Hope Farm (sunk in 1895). See p. 266. 24th April, 1898.

By Dr. J. C. THRESH.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	6·25	8·6	Calcium carbonate	15·65	21·5
Mg.	2·2	2·45	Ferrous carbonate	2·6	—
Na.	4·1	4·48	Magnesium carbonate ...	·75	—
Fe.	1·26	—	Magnesium sulphate ...	10·	12·15
CO_3	11·2	12·9	Sodium sulphate	4·6	—
SO_4	11·1	9·7	Sodium chloride	6·6	11·25
Cl.	4·	6·8	Sodium nitrate	—	1·1
NO_3	·04	·8	Aluminium oxide	·3	—
			Silica, &c.	1·5	·5
			Water of hydration... ...	1·5	—
			Total solid constituents dried at 180° C. ...	43·5	46·5
			Hardness : Temporary	16°	19°
			Permanent	12°	16°
			Total	28°	35°
			Free ammonia	·06	·008
			Organic ammonia	·005	·006
			Oxygen absorbed in 3 hours at 37° C.	·1	·08
			Nitrites	nil	nil

Stanford Rivers.

Rectory (365 ft. deep). See p. 268. 30th November, 1900.

By Dr. J. C. THRESH.

In parts per 100,000

		Probably combined as :—	
Ca.	1·6	Calcium carbonate ...	4·
Mg.	·3	Magnesium carbonate ...	1·05
Na.	35·3	Sodium carbonate ...	25·2
CO_3	17·4	Sodium sulphate	36·7
SO_4	24·8	Sodium chloride	29·9
Cl.	18·1	Sodium nitrate	1·55
NO_3	1·09	Silica, &c.	1·6
		Total solid constituents dried at 180° C.	100·
		Hardness : Total	6°
		Free ammonia	nil.
		Organic ammonia	·004
		Oxygen absorbed in 3 hours at 37° C.	·08
		Nitrites	nil.

Stansted Montfitchet.

1. Boring 152 ft., in soft Chalk (? see p. 270).

By J. W. KNIGHTS.

In parts per 100,000

Total solid matter	48·57
Chlorine expressed as sodium chloride	6·34
Free ammonia	·068
Albuminoid ammonia	·005
Oxygen absorbed by organic matter at 140° F. ...	·08

Appearance in 2-ft. tube : turbid, yellowish.
No smell when heated to 100° F.
Much deposit of Oxide of Iron.

Stansted Montfichet, cont.

2. Some other analyses :—

A.—Stansted Waterworks. Well sunk 1895. Bored deeper 1908. See p. 270. 8th February, 1900.
B.—Stansted Water Co. mains (same source as *A*). 27th February, 1912.
C.—Trial-bore Pennington Lane (? 1900). See p. 271. 7th May, 1900.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	C
Ca.	11·4	12·1	11·25
Mg.	·25	·28	·3
Na.	1·85	1·35	·72
CO_3	14·5	15·6	14·25
SO_4	1·9	2·1	1·8
Cl.	2·3	2·3	1·2
NO_3	5·	3·7	4·4

Probably combined as :—	A	B	C
Calcium carbonate ..	24·2	26·	23·75
Calcium sulphate ...	2·7	3·	2·55
Calcium chloride ...	2·5	2·2	1·9
Calcium nitrate ...	—	—	1·25
Magnesium chloride	·95	1·1	—
Magnesium nitrate ..	—	—	1·8
Sodium chloride ...	—	·13	—
Sodium nitrate ...	6·85	5·	2·7
Silica, &c.	1·3	·57	1·05
Total solid constituents dried at 180° C. ...	38·5	38·	35·
Hardness : Temporary ...	21°	23°	—
Permanent	7°	7°	—
Total	28°	30°	26°
Free ammonia	·001	·002	·012
Organic ammonia	·006	·0015	·004
Oxygen absorbed in 3 hours at 37° C. ...	·014	·015	·03
Nitrites	nil	nil	slight trace.

A.—No turbidity. Clear and colourless. *B.*—Trace of iron.

Stanway.

1. Wells at Farms.

A.—Blackitt's Farm. See p. 271. March, 1889.
B.—Cherry Tree Farm. See p. 271. 29th May, 1907.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B
Ca.	3·4	·8
Mg.	·8	·55
Na.	2·8	31·1
CO_3	1·4	21·8
SO_4	2·7	3·1
Cl.	3·1	22·8
NO_3	9·5	—

Probably combined as :—	A	B
Calcium carbonate	3·3	2·
Calcium sulphate	3·8	—
Calcium chloride	3·9	—
Magnesium carbonate ...	—	1·9
Magnesium chloride ...	·8	—
Magnesium nitrate	2·5	—
Sodium carbonate	—	34·05
Sodium sulphate	—	4·6
Sodium chloride	—	37·6
Sodium nitrate	10·4	—
Etc.	—·2	1·85
Total solid constituents dried at 180° C. ...	23·5	82·
Hardness : Temporary	1°	—
Permanent	9°	—
Total	10°	4°
Free ammonia	·003	—
Organic ammonia	·002	—
Oxygen absorbed in 3 hours at 37° C. ...	·03	—
Nitrites	nil	nil

A.—Undoubtedly affected by highly manured land around.

Stanway, cont.

2. New boring (1913) for the Lexden and Winstree Rural District Council. See pp. 271, 272.

A.—1st April, 1913. *B.*—10th May, 1913, after 13 days' pumping.

By Dr. J. C. THRESH.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	1·	·9	Calcium carbonate	2·5	2·25
Mg.	·52	·35	Magnesium carbonate ...	1·82	1·21
Na.	30·9	35·33	Sodium carbonate	34·8	34·3
CO_3	22·5	21·6	Sodium sulphate	8·8	7·11
SO_4	6·	4·8	Sodium chloride	33·	46·01
Cl.	20·	27·9	Sodium nitrate	0·	0·
NO_3	0	0	Silica, &c.	2·08	1·12
			Total solid constituents dried at 180° C. ...	83·	92·
			Hardness : Temporary	4	5
			Permanent	0	0
			Total	4	5
			Free ammonia	·058	·082
			Organic ammonia	·016	·001
			Oxygen absorbed in 3 hours at 37° C. ...	·44	·028
			Nitrites	0	0

A.—Very dull and cloudy (did not clear on filtering). Small deposit of dirt. Colour greyish. No odour. Reaction neutral to Lacmoid.

B.—Clear, slight dulness. No deposit. Slight greyish colour. No odour. Reaction neutral.

Stapleford Tawney.

Suttons. Sir C. Smith's. See p. 272. 12th December, 1900.

By Dr. J. C. THRESH.

In parts per 100,000

		Probably combined as :—	
Ca.	4·45	Calcium carbonate ...	11·15
Mg.	1·25	Magnesium carbonate ...	4·35
Na.	15·	Sodium carbonate ...	19·4
CO_3	20·8	Sodium sulphate	9·8
SO_4	6·6	Sodium chloride	8·7
Cl.	5·3	Silica, &c.	·2
NO_3	nil.		
		Total solid constituents dried at 180° C.... ...	53·6
		Hardness : Total	17°
		Free ammonia	·0
		Organic ammonia	·0026
		Oxygen absorbed in 3 hours at 37° C. ...	·07
		Nitrites	—

Steeple.

A.—Public well opposite the 'Star.' See p. 273. 1898.

B.—Cardinal's well, also in Steeple Street, 23rd July, 1913.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	1·8	—	Calcium carbonate	4·5	—
Mg.	·7	—	Magnesium carbonate	2·45	—
Na.	50·1	—	Sodium carbonate	30·3	—
CO_3	21·6	—	Sodium sulphate	9·6	—
SO_4	6·5	—	Sodium chloride	85·6	—
Cl.	51·9	52·1	Sodium nitrate	·55	—
NO_3	·4	·062	Ferric oxide and alumina oxide ...	1·	Fe. trace.
			Silica, &c.	2·	—
			Total solid constituents dried at 180° C. ...	136	135·5
			Hardness : Total	7°	6° (none permanent.)
			Free ammonia	·000	·064
			Organic ammonia	·000	·002
			Nitrites	nil	nil
			Oxygen absorbed in 3 hours at 37° C.	—	·06

B.—Faint yellow. No odour. Clear, no deposit. Reaction neutral.

Cardinal's well gave in 1903 Cl. 51·3, NO_3 ·4, and hardness 6°

Stisted.

Stisted Hall. (Boring of 1907.) In field near Rectory. For the Hall and the village. 340 ft. deep. See pp. 273, 274. 8th January, 1907.

By Dr. J. C. Thresh.

In parts per 100,000

		Probably combined as :—	
Ca.	2·6	Calcium carbonate ...	6·5
Mg.	·9	Magnesium carbonate ...	3·1
Na.	32·5	Sodium carbonate ...	22·8
CO_3	19·	Sodium sulphate	11·7
SO_4	7·9	Sodium chloride	47·8
Cl.	29	Nitrates, silica, &c. ...	3·1
NO_3	—		
		Total solid constituents dried at 180° C....	95·
		Hardness : Total	8·5°
		Free ammonia	·12
		Organic ammonia	·004
		Oxygen absorbed in 3 hours at 37° C. ...	·024
		Nitrites	nil.

Clear.

Sturmer.

A.—The Nurseries (Mr. F. E. Dillestone's). Deep well (see p. 275). 25th September, 1912.

B.—Mr. Hoffman's boring. 27th September, 1912.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	19·5	28·1	Calcium carbonate	35·5	37·5
Mg.	4·7	2·7	Calcium sulphate	18·	44·54
Na.	8·84	9·75	Magnesium sulphate ...	23·2	13·34
CO_3	21·3	22·5	Sodium sulphate	8·6	8·76
SO_4	37·	48·	Sodium chloride	15·	17·31
Cl.	9·1	10·5	Sodium nitrate	·53	·36
NO_3	·39	·26	Silica, &c.	1·2	2·
			Iron, organic matter, &c. ...	—	4·19
			Total solid constituents dried at 180° C. ...	102·	128·
			Hardness: Total	64°	90°
			Free ammonia	·004	·014
			Organic ammonia	·002	·004
			Oxygen absorbed in 3 hours at 37° C. ...	·024	·064
			Nitrites	nil	nil

A.—Dull. Yellowish. No odour. Reaction neutral.

B.—Turbid (due to Iron Oxide). Brownish yellow. No odour.

Terling.

1. Middleditch well. 2. School well. 3. Lines well. 4. Terling Place well. See p. 277.

By Prof. Miller, F.R.S., *Tenth Rep. Med. Off. Privy Council*, 1868, pp. 52, 53.

Grains per gallon.

	1	2	3	4
Colour in 2 foot tube ...	Greenish yellow.	—	Greenish yellow.	—
Sediment	Considerable. Brown.	Clear. A few flakes.	Distinct brown.	Clear. A few flakes.
Odour	None perceptible when warmed.			
Taste...	None perceptible.			
Hardness before boiling ...	25·6°	24·8°	18·2°	15·3°
,, after boiling 1 hour	16·5°	4·6°	17·4°	7·2°
Total solids...	51·9	27·1	38·6	25·7
Fixed salts	50·3	25·6	36·2	23·2
Volatile and combustible ...	1·6	1·5	2·4	2·5
Nitric acid	6·67	Trace.	2·56	3·05
Ammonia	0·04	none.	Traces.	none.
Action on permanganate of Potash	Considerable.	Very little.	Considerable.	Little.
Cubic inches of gas per gallon	22·8	15·	9·	12·
Consisting of—				
Carbonic acid ...	9·57	6·35	3·6	6
Oxygen	3·08	2·31	·9	1·38
Nitrogen	10·17	6·34	4·5	4·62
Ratio of oxygen to nitrogen	1:3·3	1:2·75	1:5	1:3·3

Terling, cont.

1. Is a bad water. Contamination by animal refuse is indicated by the large proportions of Nitrates, Ammonia, and Chlorides. Amount of organic matter not large, but in an active state of decomposition, reducing Permanganate rapidly. 3 is similar to 1, but perhaps less objectionable, as it contains less Nitrates and Ammonia. Amount of organic matter large and as in 1, having considerable reducing action on Permanganate. Amount of Chlorides considerable. In both 1 and 2 the aeration is defective.

2 is unobjectionable. Contains no sensible amount of Ammonia or Nitric Acid and is nearly free from Chlorides. Organic matter slight and with little reducing action on Permanganate.

4 is next to 2 in order of merit. It is not a first-class water. Organic matter considerable, but with little reducing action on Permanganate. The Ammonia is insignificant, but the amount of Nitrates present is more important. The amount of Sulphates and Chlorides is small. Aeration less perfect than in 2.

Some analyses by Prof. J. T. Way, for the Rivers Pollution Commission.

Apparently not published in its Report.

A.—Lyne's well. Received 17th February, 1868.

B.—Francis' Green well. Received 17th February, 1868.

C.—Flack's Green well. Received 17th February, 1868.

D.—Well at Bromlees. Received 17th February, 1868.

E.—Terling Place. Well used for domestic purposes. ? See p. 277. Reported on April, 1868.

F.—Terling Place. Well bored through 200 ft. of London Clay. Reported on April, 1868.

G.—Terling Place. Old well used for garden. Reported on April, 1868.

H.—Terling Place. Private cottage-well. Reported on April, 1868.

I.—Terling Place. Private cottage-well. Reported on April, 1868.

For analyses of three spring-waters, made at the same time, see p. 352.

Terling, cont.

In parts per 100,000 (except Hardness which is in grains per gallon degrees).

	A	B	C	D	E	F	G	H	I
Hardness: Temporary ...	10·45	10·89	12·85	17·21	12·56	8·21	15·51	17·42	17·97
Permanent ...	7·96	1·24	·76	5·57	2·37	8·39	14·6	14·04	7·36
Total ...	18·41	12·13	13·61	22·78	14·93	16·6	30·11	31·46	25·33
Sodium chloride	6·66	3·64	13·	3·33	3·17	10·07	10·23	19·59	9·34
Nitrogen from ammonia	·017	·0144	·01	0	—	-	—	—	—
Ammonia	—	—	—	—	·01	·01	·011	·0205	·01
Nitrogen from albuminous matter ...	·0135	·0094	·022	·002	—	—	—	—	—
Albuminous matter	—	—	—	—	·1	·019	·28	·18	·15
Nitrogen from nitric acid	1·82	·0123	·9283	·4563	—	—	—	—	—
Nitric acid	—	—	—	—	·0052	·0056	·014	·0234	·0111
Mineral residue	55·5·	42·5	44·54	38·9	33·8	42·64	77·	106·24	62·1

A.—Not of good quality. Contains a somewhat high proportion of mineral residue and an unusually large quantity of Nitrates, showing pollution to some extent.

B.—Turbid. The analysis is after filtration. When filtered there is nothing to complain of. Unfiltered it gives nearly twice as much albuminous matter, which tends to show that the water, otherwise pure, is contaminated by surface-washings.

C.—Contains high proportion of albuminous matter and Common Salt. "I am not prepared to say that it is polluted to a dangerous extent," but it is open to suspicion and should be avoided.

D.—Excellent though hard. Evidently from the Chalk. Free from animal matter.

E.—Not open to complaint.

F.—A fair water, but containing more Ammonia and albuminous matter than one would expect.

G.—By no means fitted for human consumption.

H and *I* are "anything but good," *H* having high proportions of Common Salt and Nitric Acid and a high mineral residue.

Thorpe-le-Soken.

Boring near Free's Maltings and railway-station. See p. 278.

By Dr. J. C. Thresh. 25th May, 1898.

In parts per 100,000

Ca.	3·8	Probably combined as :—	
Mg.	1·2	Calcium carbonate	9·5
NH_4	·1	Magnesium carbonate	4·2
Na.	66·45	Sodium carbonate	16·4
CO_3	18·	Sodium sulphate	29·45
SO_4	19·9	Sodium chloride	126·4
Cl.	76·6	Ammonium nitrate	·4
NO_3	·3	Silica, &c.	·65
		Total solid constituents dried at 180° C....	187·

Hardness: Temporary, 12°; Permanent, 5°; Total 17°.

Free ammonia	·096
Organic ammonia	·003
Oxygen absorbed in ¼ hour at 100° C. ...	·152
Nitrites	nil.

Thundersley.

1. Southend Water Co. Thundersley Well. See pp. 278, 279.

By Dr. J. C. Thresh.

A.—14th January, 1909.

B.—25th June, 1910. Sample taken when well was being deepened.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	·8	1·	Calcium carbonate ...	2·	2·5
Mg.	·3	·2	Magnesium carbonate ...	1·05	·69
Na.	33 78	34·94	Sodium carbonate ...	26·55	28·31
CO_3	17	18	Sodium sulphate	12·3	13·2
SO_4	8·3	8·9	Sodium chloride	46·3	46·5
Cl.	28·1	28·2	Sodium nitrate	·25	·16
NO_3	·17	·12	Silica, &c.	1·55	·64
			Total solid constituents dried at 180° C.	90·	92·
			Hardness: Total	3·5°	3·5°
			Free ammonia	·028	·058
			Organic ammonia	·002	·002
			Oxygen absorbed in 4 hours at 27° C. ...	·04	·06
			Nitrites	trace.	nil.

B.—Very clear. Very slight yellow. No odour.

Thundersley, cont.

2. Burches pumping-station. Southend Water Co. See pp. 279, 280.

By Dr. J. C. Thresh. 14th January, 1909.

In parts per 100,000

		Probably combined as :—	
Ca.	1·	Calcium carbonate ...	2·5
Mg.	·3	Magnesium carbonate ...	1·1
Na.	35·2	Sodium carbonate ...	27·
CO_3	17·6	Sodium sulphate	13·3
SO_4	9·	Sodium chloride	48·5
Cl.	29·4	Sodium nitrate	·25
NO_3	·15	Silica, &c.	1·35
		Total solid constituents dried at 180° C.	94
		Hardness: Total	4·3°
		Free ammonia	·048
		Organic ammonia	·000
		Oxygen absorbed in 4 hours at 27° C....	·032
		Nitrites	minute trace.

Tillingham.

A.—Tillingham Hall, near the church (5-in. bore, 495 ft. deep). See p. 280. 14th October, 1911.

B.—Marsh Farm. Partial analysis (boring 300 ft. deep). See p. 281, and remarks on Salt Water, p. 35. October, 1911.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as:	A	
Ca.	1·2	—	Calcium carbonate ...	3·	B is higher in Salt (sodium chloride) than A, as is indicated by the figures for Cl. (chlorine). Similar to A in other mineral respects.
Mg.	·55	—	Magnesium carbonate	1·9	
Na.	59·35	—	Sodium carbonate ...	39·9	
CO_3	25·7	21·4	Sodium sulphate ...	8·8	
SO_4	6·	6·1	Sodium chloride ...	99·3	
Cl.	60·2	76·3	Sodium nitrate ...	·5	
NO_3	·4	—	Silica, &c.	·6	
			Total solid constituents dried at 180° C.	154	—
			Hardness: Total	8°	8·5°
			Free ammonia	·09	—
			Organic ammonia	·003	—
			Oxygen absorbed in 3 hours at 37° C. ...	·22	—
			Nitrites	nil	—

A.—Turbid (chalky). Whitish in colour. No odour.

B.—Beautifully clear and bright.

Tiptree.

Tiptree Heath Brewery (Thorn and Livermore's). Well deepened to 601 ft.

See p. 281.

By Dr. J. C. Thresh. 24th May, 1898.

In parts per 100,000

Ca.	·925	Probably combined as :—	
Mg.	·8	Calcium carbonate ...	2·3
Na.	64·7	Magnesium carbonate ...	2·8
CO_3	26·6	Sodium carbonate ...	40·95
SO_4	17·8	Sodium sulphate	26·35
Cl.	58·9	Sodium chloride	97·2
NO_3	·3	Sodium nitrate	·4
		Silica, &c.	1·
		Total solid constituents dried at 180° C. ...	171·

Hardness: Temporary, 4°; Permanent, 0°; Total, 4°.

Free ammonia	·008
Organic ammonia	·102
Oxygen absorbed in 3 hours at 37° C. ...	·04
Nitrites	nil.

Tollesbury.

Analyses by Dr. J. C. Thresh.

A.—Wick Marsh Farm. See p. 282. 8th November, 1908.

B.—High Street. Public pump. Well 10 to 12 ft. deep. February, 1900.

C.—Trial-bore. Maldon Rural District Council. 358 ft. deep, 1912. See p. 282. Sample when bore 187 ft. down and water-level 66 ft. down. 19th January, 1911.

D.—Same when 256 ft. deep and water-level 68 ft. down. 15th March, 1911.

E.—Same when complete. Taken on the last day of 16 days' test-pumping. 21st July, 1912.

Tollesbury, cont.

In parts per 100,000

	A	B	C	D	E
Ca.	1·2	14·8	2·1	1·7	1·2
Mg.	·65	3·	·62	·56	·82
K.	—	8·8	—	—	—
Na.	63·95	12·	74·09	68·29	68·24
CO_3	25·2	8·4	23·	24·2	24·3
SO_4	8·8	26·5	27·4	8·2	9·6
Cl.	66·2	16·2	72·1	75·	73·6
NO_3	·05	24·4	·25	·25	·25
PO_4	—	trace	—	—	—

Probably combined as :—	A	B	C	D	E
Calcium carbonate...	3·	14·	5·25	4·25	3·
Calcium sulphate	—	31·3	—	—	—
Magnesium carbonate	2·15	—	2·14	1·93	2·84
Magnesium sulphate	—	5·5	—	—	—
Magnesium chloride	—	7·5	—	—	—
Sodium carbonate	38·55	—	32·43	35·88	36·23
Sodium sulphate	13·	—	40·5	12·1	14·2
Sodium chloride	109·2	17·5	118·9	123·7	121·4
Sodium and potassium nitrates ...	—	39·8	·34	·34	·34
Silica, organic matter, &c. ...	1·3	4·7	·44	·8 some iron	·99
Total solid constituents dried at 180° C. ...	167·	120·3	200·	179·	179·
Hardness: Temporary	—	11°	13°	—	7°
Permanent	—	33°	2°	—	0°
Total	7°	44°	15°	10°	7°
Free ammonia	·104	·000	·145	·12	·004
Organic ammonia	·003	·013	·004	·006	·002
Oxygen absorbed in 3 hours at 37° C.	—	·173	·252	·236	·021
Nitrites	nil	nil	nil	nil	nil

A.—Marsh-water may get into the well but not into the bore-pipe (which is 8 ft. above the bottom of the well). Appearance clear. Sample from bore-pipe.

B.—Fairly bright. Yellow tint. No odour. Reaction neutral. Examined because in centre of ancient village. Sometimes turbid.

C.—Very cloudy. Large deposit of dirt and fine sand. Blackish-grey. No odour.

D.—Cloudy. Deposit of sand. Yellowish-grey. No odour.

E.—Deposit of grey sand. Clear on standing. Grey. No odour.

Tolleshunt D'Arcy.

Well at High Hall (Farm) 39 ft. deep (see p. 283).
Analysis from the County Technical Laboratories.

	In parts per 100,000
Total solids	699·
Chlorine in chlorides	162·5
(equal to common salt) ...	(267)
Nitrogen as nitrates	·69
Temporary hardness	47·5°
Permanent hardness	99·5°
Free ammonia	·009
Albuminoid ammonia	·035
Oxygen absorbed	·265

Quite unfit for any purpose.
Dr. Thresh comments on the extraordinary amount of salt in this water from a well the bottom of which was 79 ft. above mean sea-level.

Ulting.

Vicarage. Well in the grounds. See p. 284. 13th April, 1910.
By Dr. J. C. Thresh.

		Probably combined as :—	In parts per 100,000
Ca.	1·2	Calcium carbonate ...	3
Mg.	·7	Magnesium carbonate ...	2·3
Na.	51·7	Sodium carbonate ...	36·8
CO_3	24·2	Sodium sulphate	15·4
SO_4	10·4	Sodium chloride	77·8
Cl.	47·2	Sodium nitrate	·42
NO_3	·31	Etc.	·28

Total solid constituents dried at 180° C. 136

Hardness : Total ... 5·5°

Free ammonia	·032
Organic ammonia	·003
Oxygen absorbed in 3 hours at 37° C.	·04
Nitrites	nil.

Upminster.

Upminster Court, Hall Lane. Well in stable-buildings. See p. 285.
By Dr. J. C. Thresh. 4th September, 1911.

		Probably combined as :—	In parts per 100,000
Ca.	1·1	Calcium carbonate ...	2·75
Mg.	·36	Magnesium carbonate ...	1·24
Na.	25·57	Sodium carbonate ...	24·67
CO_3	16·5	Sodium sulphate	9·92
SO_4	6·7	Sodium chloride	29·52
Cl.	17·9	Sodium nitrate	·1
NO_3	·07	Silica, &c.	·3

Total solid constituents dried at 180° C.... 68·5

Hardness : Temporary, 4°; Permanent, 0°; Total, 4°.

Free ammonia	·066
Organic ammonia	·000
Oxygen absorbed in 3 hours at 37° C. ...	·04
Nitrites	nil.

Vange.

A.—Main well. Southend Water Co. See p. 158. 18th December, 1908.

B.—Auxiliary well Southend Water Co. See pp. 158, 159. 18th December, 1908.

C.—West well. Southend Water Co. See p. 159. August, 1911 (before being brought into use).

D.—West well. Southend Water Co. 9th January, 1912.

E.—Curtis' well. North of road above Curtis' brickyard. See pp. 285, 286. 8th April, 1898.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	C	D	E
Ca.	·95	·8	1·	1·3	·8
Mg.	·5	·35	·35	·61	·36
Na.	29·65	26·95	26·95	27·39	27·15
CO_3	15·9	15·6	18·6	17·	16·5
SO_4	21·8	13·4	17·	20·24	7·2
Cl.	14·	15·6	9·4	11·2	18·6
NO_3	·15	·15	·1	·14	·17

Probably combined as :—	A	B	C	D	E
Calcium carbonate ...	2·4	2·	2·5	3·25	2·
Magnesium carbonate ...	1·75	1·2	1·2	2·11	1·25
Sodium carbonate ...	23·3	23·95	28·9	23·98	25·4
Sodium sulphate	32·2	19·8	25·15	29·95	10·65
Sodium chloride	23·1	25·7	15·5	18·4	30·7
Sodium nitrate	·2	·2	·15	·19	·25
Silica, &c.	·55	1·15	1·4	·42	1·75
Total solid constituents dried at 180° C.	83·5	74·	74·8	78·3	72·
Hardness: Temporary ...	—	—	4°	4°	6°
Permanent ...	—	—	2°	1·5°	0°
Total ...	6°	4°	6°	5·5°	6°
Free ammonia	·068	·056	·088	·084	·05
Organic ammonia	·004	·003	·0046	·0024	·001
Oxygen absorbed in 3 hours at 37° C. ...	·076	·056	·066	·026	·06
Nitrites	nil	nil	nil	nil	nil

A. B. C.—are really in the parish of Fobbing.

Waltham Abbey.

1. East London Waterworks (Metropolitan Water Board.)
See pp. 289, 290.

From Dr. HOUSTON's Report to the Metropolitan Water Board for 1910, p. 51.

5th January, 1910.

	In parts per 100,000
Calcium carbonate	14·98
Magnesium carbonate	4·54
Sodium carbonate	0
Magnesium sulphate	2·9
Sodium sulphate	4·49
Sodium chloride with a little potassium chloride ...	3·36
Sodium nitrate	0·06
Sesquioxide of iron and alumina	·17
Silica	1·7
Difference	+ ·02
Total solids... ...	32·22

Hardness: Temporary, 7·82; Permanent, 9·49; Total, 17·31.

Chlorine	2·03
SO_4 (calculated from SO_3)	5·35
Calcium (calculated from CaO)	6·
Magnesium (calculated from MgO)	1·88

Waltham Abbey, cont.

2. Various Waltham Abbey Wells.

A.—East London Water-works (now Metropolitan Water Board). (Sunk 1888.) See pp. 289, 290. 7th April, 1898.
B.—Same source. From the main. 28th December, 1911.
C.—H. O. Larsen's Nurseries. Deep well. See p. 288. 7th September, 1912.
D.—Galley Hill. Aime's Green well (sunk 1898. 347 ft. deep). See p. 287. 21st December, 1909.
E.—Monkham Park (Monkham Hall, new map). ($220\frac{1}{3}$ ft. deep. See pp. 288, 289.) 22nd December, 1909.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	C	D	E
Ca.	5·05	6·7	6·1	1·	16·8
Mg.	1·3	1·1	2·5	5·5	9·
Na.	3·15	3·87	8·04	25·3	48·86
CO_3	10·8	12·8	16·2	18·6	5·7
SO_4	3·5	4·8	10·3	11·8	134·
Cl.	2·3	2·3	3·4	10·8	25·6
NO_3	·0	·2	·13	·15	·44

Probably combined as :—	A	B	C	D	E
Calcium carbonate ...	12·65	16·75	15·2	2·5	9·5
Calcium sulphate	—	—	—	—	44·2
Magnesium carbonate ...	4·5	3·85	8·6	1·9	—
Magnesium sulphate ...	—	—	—	—	44·4
Sodium carbonate ...	—	—	1·8	27·85	—
Sodium sulphate	5·2	7·1	15·3	17·5	99·5
Sodium chloride	3·65	3·8	5·6	17·8	42·2
Sodium nitrate	—	·27	·17	·2	·6
Silica, &c.	—	·23	·33	1·25	2·6
Total solid constituents dried at 180° C.	26·	32·	47·	69·	243·
Hardness : Temporary ...	13°	16·	—	—	—
Permanent	4°	6·	—	—	—
Total	17°	22·	20°	4·5°	85°
Free ammonia	·000	·006	·05	·084	·002
Organic ammonia	·002	·006	·006	·004	·016
Oxygen absorbed in 3 hours at 37° C. ...	·022	·049	·066	·1	·075
Nitrites	nil	nil	nil	nil	nil

A.—Compare with the following analysis *B.*
B.—Clear and bright. No deposit. Very faint yellow. No odour. Reaction neutral.
C.—Chalky deposit. Greyish. No odour. Reaction neutral.
D.—Turbidity; a little fine sand. Yellow tint. No odour. Reaction alkaline.

Walthamstow.

A.—Electric Supply Station. Priory Avenue. See p. 293. 26th May, 1909. Unsoftened. (The supply is softened by Patterson Potash Process.) Sample taken from open tank.

B.—Messrs. Houghton's Photographic Works. See p. 293. Taken from an overhead open tank. 26th May, 1909.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	8·6	3·5	Calcium carbonate ...	21·5	8·7
Mg.	1·1	1·7	Magnesium carbonate ...	·4	5·9
Na.	2·1	6·6	Magnesium sulphate ...	4·9	—
CO_3	13·2	12·8	Sodium carbonate ...	—	6·
SO_4	4·6	4·1	Sodium sulphate	1·	6·1
Cl.	2·4	2·4	Sodium chloride	4·	4·
NO_3	·6	1·1	Sodium nitrate	·8	1·5
			Suspended matter, &c. ...	3·4	—
			Total solid constituents dried at 180° C. ...	36·	32·2
			Free ammonia ...	·0116	·0806
			Organic ammonia ...	·0122	·001
			Poisonous metals ...	None.	Absent.
			Turbidity	Yellowish flocculent.	None. Clear and bright.
			Colour	Slight yellowish green.	Slight greenish.
			Odour	None.	—

Walton-on-Naze.

G. W. Wigner. The Water Supply of Sea-side Watering Places, 1878, pp. 15–18.

The supply was from a deep well, from which no sample could be got.

A.—Well-supply. Sample taken from a main pipe.

B.—From Turpin's Farm pump.

C.—From Walford's Farm pump.

In parts per 100,000.

	A	B	C
Total solid matter	116·14	88·	45·
Loss on ignition, after deducting combined CO_2	29·229	18·04	11·06
Iron...	0	heavy trace.	heavy trace.
Chlorine, calculated as chloride of sodium	29·121	27·57	18·89
Hardness before boiling, Clark's scale ...	30°	22°	14°
,, after boiling, Clark's scale ...	24°	13·2°	13·4°
Nitrogen as ammonia	·0023	·0023	·0034
,, albuminoid ammonia ...	·005	·0109	·0144
,, nitrates	4·589	3·031	·65
,, nitrites	·0071	·011	·014
Total nitrogen in the four forms ...	4·603	3·059	·683
Oxygen absorbed by organic matter ...	·0046	·061	·1691

A.—Water free from offensive smell. Taste briny. Colour fair. Microscopic examination showed that the sediment consisted mainly of earthy matters.

B.—Very unsatisfactory in microscopic appearance, containing many living organisms. Most offensive smell and taste, the latter showing that there had been *recent* urinary contamination.

C.—A more satisfactory appearance under the microscope, but smell and taste both unpleasant.

The above, of course, refers to a past state of things.

West Bergholt.

Daniell's Brewery. Deep well to Chalk. See p. 297.

By R. T. Daniell. 1881.

	In parts per 100,000
Sodium chloride	60·82
Sodium carbonate	22·71
Sodium sulphate	15·47
Calcium carbonate	8·64
Magnesium carbonate	3·62
Silica	2·5
Alumina, oxide of iron, &c.	·5
Organic matter and loss in analysis	·73
Total solids	115
Free ammonia	·012
Albuminoid ammonia	·018
Chlorine	36·93

Hardness: Permanent, 5·6°; Temporary, 4·4°; Total. 10°.

West Ham.

Stratford. *A.*—Boring. Sugar House Lane. One-sixth of a mile north-west of Three Mills and one-sixth of a mile south-east of Queen Matilda's Causeway (240 ft. deep). 16th December, 1904.
Stratford. *B.*—Great Eastern Railway works (? the bore of 1908). See pp. 300, 301. 6th July, 1909.
Stratford. *C.*—Messrs. Howard and Sons. See pp. 301, 302. 12th January, 1901.
Stratford. *D.*—Forest Gate Sanitary Laundry. Upton-road (250 ft. deep). See p. 304. 16th November, 1909.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	C	D
Ca.	9·8	6·5	6·6	5·1
Mg.	1·9	2·5	2·8	1·7
Na.	4·	5·26	5·2	5·8
Fe.	0	—	—	—
CO_3	17·5	13·6	17·	13·
SO_4	4·8	6·6	5·6	5·
Cl.	4·2	6·	3·65	3·7
NO_3	·2	·45	·4	·25

Probably combined as :—	A	B	C	D
Calcium carbonate	24·5	16·2	16·5	12·7
Magnesium carbonate	3·9	5·	9·8	5·9
Magnesium sulphate	3·2	5·4	—	—
Sodium carbonate	—	—	—	2·1
Sodium sulphate	3·6	3·4	8·3	7·4
Sodium chloride	6·9	10·	6·	6·1
Sodium nitrate	·3	·6	·55	·35
Silica, &c.	1·7	1·2	·85	·45
Total solid constituents dried at 180° C....	44·1	41·8	42·	35·
Hardness: Temporary ...	22°	10°	—	11°
Permanent ...	6°	14°	—	5·5°
Total ...	28°	24°	—	16·5°
Free ammonia	·004	·076	—	·031
Organic ammonia	·001	·0016	—	·001
Oxygen absorbed in 3 hours at 37° C. ...	—	·013	—	·028
Nitrites	nil	nil	—	nil
Turbidity	—	none	—	clear and bright.
Colour	—	slight green-ish.	—	faint green.
Odour	—	none	—	none
Reaction	—	—	—	alkaline

West Mersea.

A.—Waldegraves Farm. See p. 305. 1900.
B.—Waldegraves Cottages. See p. 306. 15th September, 1911.
C.—New Victory Inn. See p. 305. 15th February, 1908.
D.—Creek Hall. See p. 305. June, 1909.

By Dr. J. C. Thresh.

	A	B	C	D
Ca.	15·6	2·2	1·75	1·3
Mg.	7·7	1·5	1·3	·7
Na.	26·7	75·3	67·85	71·65
Fe.	—	—	·2	—
CO_3	26·6	25·4	19·4	23·
SO_4	36·3	15·5	14·2	14·4
Cl.	33·3	83·	78·	76·4
NO_3	·15	—	minute trace.	·4

In parts per 100,000

	A	B	C	D
Probably combined as :—				
Calcium carbonate	39·	5·5	4·35	3·2
Magnesium carbonate	4·55	5·2	4·55	2·4
Magnesium sulphate	32·	—	—	—
Sodium carbonate	—	32·5	23·85	34·3
Sodium sulphate	15·7	22·9	21·15	21·3
Sodium chloride	54·9	136·8	128·7	126·1
Sodium nitrate	·2	·0	—	·55
Silica, &c.	9·95 (largely organic)	·6 (some iron).	6·4 traces of organic matter. Clay & iron oxide.	2·15
Total solid constituents dried at 180° C. ...	156·3	203·5	189·	190·
Hardness: Temporary ...	20°	12·8°	—	—
Permanent ...	20°	0°	—	—
Total ...	40°	12·8°	—	—
Free ammonia	·012	·124	·1	—
Organic ammonia	·028	·012	·006	—
Oxygen absorbed in 3 hours at 37° C. ...	·209	·88	—	—
Nitrites	nil	traces.	—	—

A.—Yellowish. Evidently impure. *C.*—Very dull. Deposit of fine sand and Iron Oxide.

West Thurrock.

1. Purfleet. ? Pure Oil Co.

Made by R. A. Cripps, 1904. Communicated by Messrs. Duke and Ockenden.

	In parts per 100,000
Total solids	307·1
Chlorine	127·
Ammonia	·0863
Albuminoid ammonia	·001
Nitrogen, as nitrites or nitrates ...	nil.
Hardness (Clark's scale)	69·3°

Microscopic examination, Mineral matter and a few algae.

This water is not suited for boiler-use. The large proportion of dissolved solids and especially the high degree of hardness, due largely to Magnesium-salts, would render it very troublesome, by acting on the boiler-plates and fittings.

For the same cause it is of second-rate quality for drinking purposes.

2. Purfleet. Thames Paper Co. See pp. 306–308.

By Dr. J. C. Thresh. *A.*—March, 1910; *B.*—June, 1915.

In parts per 100,000

	A	B	Probably combined as :—	A	B
Ca.	23·8	28·5	Calcium carbonate ...	28·	30·7
Mg.	14·1	32·	Calcium sulphate... ...	42·8	55·4
Na.	202·6	321·1	Magnesium sulphate ...	24·3	79·3
CO_3	16·8	18·5	Magnesium chloride ...	36·	62·5
SO_4	49·6	102·4	Sodium chloride	513·2	814·2
Cl.	338·	540·	Sodium nitrate	2·3	1·4
NO_3	1·7	1·	Silica, &c.	2·4	1·5
			Total solid constituents dried at 180° C. ...	649·	
			Hardness : Total	200°	Over 200
			Free ammonia	·052	·12
			Organic ammonia	·004	·014
			Oxygen absorbed in 3 hours at 37° C. ...	·088	·21
			Nitrites	Very minute trace.	nil.

West Tilbury.

Mr. Cole's cottages, near Low Street Station. See p. 308.

By Dr. J. C. Thresh. 14th May, 1900.

In parts per 100,000

		Probably combined as :—	
Ca.	11·4 ...	Calcium carbonate ...	23·55
Mg.	1·2 ...	Calcium sulphate... ...	6·8
Na.	5·95 ...	Magnesium sulphate ...	4·
CO_3	14·15 ...	Magnesium chloride ...	1·6
SO_4	8· ...	Sodium chloride	5·45
Cl.	4·5 ...	Sodium nitrate	*14·1
NO_3	10·3* ...	Silica, &c.	1·5
		Total solid constituents dried at 180° C....	57·
		Hardness : Total	37°
		Free ammonia	·001
		Organic ammonia	·005
		Oxygen absorbed in 3 hours at 37° C.	·028
		Nitrites	nil.

* The Nitrates (NO_3) suggest the presence of a good deal of subsoil water.

Wicken Bonhunt.

1. Parish well. By A. MATTHIESSEN, in Sir G. BUCHANAN's Report, 1870. p. 77. November, 1869.

	In parts per 100,000	
	Before the well was cleaned.	After the well was cleaned.
Solid residue	39·43	39·86
Mineral matter ...	34·29	37·86
Organic matter ...	5·14	2·
Chlorine = common salt ...	—	2·86
Nitrogen as nitric acid ...	—	·97
Total hardness	—	18·6°
Hardness after boiling ...	—	10·6°

"The water from the well, after cleaning, ought not exactly to be condemned."

2. Other analyses, from samples all collected on November 22nd, by Prof. MILLER. *Ibid.*, p. 78. Apparently in grains per gallon.

	Holland's well.	Old (parish) well.	Graystone's well.
Fixed salts	32·3	24·45	4·15
Volatile and combustible	1·9	2·15	1·25
Total soluble matters	34·2	26·6	44·4
Nitric acid	·64	·56	1·42
Ammonia from its salts	·002	·003	·003
Organic ammonia	·01	·008	·006
Oxygen required from permanganate to oxidize organic matter ...	·06	·0656	·062
Hardness on Clark's scale	26·4°	21·1°	28°
,, after boiling an hour ...	4·5°	5·5°	4·2°

Scanty sendiment in all.

"The quantity of nitrates is unimportant, but the organic matter though not large in amount objectionable. . . . The proportion of salts of ammonia, though not great, is still distinctly more than good waters usually contain."

Dr. [Sir B.] SANDERSON reported on the sediments, etc., sent him by Prof. MILLER. *Ibid.*, p. 79.

The water from Graystone's well and old well have like characters. Both "are richly peopled with microzymas. These consist of spheroidal particles (sporoids) and bacteridia. The sediment consists partly of organic debris . . partly of minute masses of faulty granular matter. Each of these masses teems with microzymas. . "

"In addition to these forms, there are two species of monads which exist in great numbers, numerous amœbœ and a certain number of paramecia."

The waters from Holland's well "is also rich in microzyams," but not to such great extent. "A species of monad abounds. . . . Amœbœ are also plentiful."

"From these facts it is to be concluded that all these waters, especially those first described, are in a state of active putrefactive change."

Wicken Bonhunt, cont.

3. The Rectory. See p. 319. 26th October, 1912.

By Dr. J. C. Thresh.

In parts per 100,000

		Probably combined as :—	
Ca.	12·8	Calcium carbonate ...	31·5
Mg.	·4	Calcium sulphate... ...	·7
Na.	·7	Magnesium sulphate ...	1·4
CO_3	18·9	Magnesium chloride ...	·4
SO_4	1·6	Sodium chloride	1·8
Cl.	1·4	Sodium nitrate	·0
NO_3	·0	Silica, &c.	2·2
		Total solid constituents dried at 180° C....	38·

Hardness: Temporary, 31·6°; Permanent, 5·4°; Total, 37°

Free ammonia	·0
Organic ammonia	·006
Oxygen absorbed in 3 hours at 37° C.	·045
Nitrites	·0

Clear. Slight dulness perceptible but no deposit. Faint grey. No odour. Reaction neutral.

Wickham Bishop.

A.—Proposed asylum. Deep boring into Chalk. See pp. 311, 312. By Prof. C. M. Tidy. January, 1880.

B.—Well in railway-cutting southward of Wickham Bishop station. See p. 312. By Dr. P. F. Frankland. July, 1889.

C.—Spring in same cutting. Also by Frankland. July, 1889.

In parts per 100,000

	A	B	C
Total solid matter	190·21	29·28	30·12
Lime (CaO)	3·91	—	—
Magnesia (MgO)	2·316	—	—
Sulphuric anhydride (SO_3)	12·38	—	—
Chlorine	74·88	2·5	2·5
Nitrogen as nitrates and nitrites	·171	1·029	·973
Organic nitrogen	·026	·012	·036
Total combined nitrogen	(·197)	1·042	1·009
Organic carbon	·054	·088	·16
Ammonia	·0014	·001	—
Oxygen required to oxidize organic matter ...	·016	—	—
Hardness: Permanent	·8°	5·1°	4·9°
Temporary	2·5°	9·8°	9·4°
Total	3·3°	14·9°	14·3°

A.—Of the 190·21 grains of solid matter nearly 123 were common salt (Sodium Chloride).

The organic matter is very small and organically the water is very pure. The quantity of solid matter is enormous, while the salt present shows that the water is 'unusual.' The last is no indication of organic impurity.

Free from suspicion as regards wholesomeness, but it is a question whether it would be palatable. Well fitted in every respect as regards ordinary detergent purposes.

B and *C.*—Slightly turbid. Palatable. (A second analysis of the water from the (? new) well in the cutting gave very similar figures but showed less sign of surface-contamination. W. T. Foxlee, 1889.)

Witham.

Waterworks.

A.—Old well (1869), 500 ft. deep. See p. 315. 4th June, 1899.

B.—Bore at newer works (1902), 600 ft. deep, 279 ft. to Chalk. See pp. 315, 316. 5th April, 1902.

C.—Second bore of 1902 (near *B*), 600 ft. deep and 294 to Chalk. 7th November, 1902.

D.—From a tap in a house, Maldon Road. From both borings (*B* and *C* mixed). 26th September, 1911.

By Dr. J. C. Thresh.

	A	B	C	D
Ca.	1·	1·4	2·	1·1
Mg.	·75	·1	1·	·35
Na.	45·3	48·57	42·6	45·96
K.	4·	—	—	—
CO_3	21·4	19·	18·5	17·6
SO_4	5·4	8·2	8·5	7·3
Cl.	48·1	49·	43·8	47·5
NO_3	0	·06	·12	·18

In parts per 100,000

	A	B	C	D
Probably combined as :—				
Calcium carbonate	2·5	3·5	5·	2·75
Magnesium carbonate	2·65	·35	3·5	1·21
Sodium carbonate	31·8	29·4	23·	26·69
Sodium sulphate	8·	12·15	12·6	10·8
Sodium chloride	73·35	80·85	72·3	78·3
Potassium chloride	7·65	—	—	—
Sodium nitrate	0	} 1·75	2·1	{ ·24
Silica, &c.	·55		some chalk suspended	{ ·51
Total solid constituents dried at 180° C. ...	126·5	128·	118·5	120·5
Hardness : Temporary	3°	3·5°	8·5	—
Permanent	1°	1·5°	1·5	—
Total	4°	5°	10°	—
Free ammonia	·06	·104	·100	·001
Organic ammonia	·008	·006	·002	·002
Oxygen absorbed in 3 hours at 37° C. ...	·084	·014	·024	·036
Nitrites	very minute trace.	nil	nil	nil

A.—A little sandy.
C.—Faintly turbid.
D.—Very clear. Very faint yellow. No odour. Reaction neutral.

Witham, cont.

? An older analysis of *A* of the previous group of analyses. The depth of the well is given as 600 ft. From the *Sixth Rep. Riv. Poll. Comm.*, 1874, p. 103.

3rd April, 1873.	In parts per 100,000
Temperature C., 10·6°	—
Total solid impurity	67·5
Organic carbon	·07
Organic nitrogen	·016
Ammonia	·024
Nitrogen as nitrates and nitrites	·645
Total combined nitrogen	·681
*Previous sewage or animal contamination ...	6,320
Chlorine	15·2
Hardness: Temporary, 21·2; Permanent, 7; Total, 28·2.	

Slightly turbid. **Palatable.**

One of 13 samples of water from deep wells in Chalk beneath London Clay. The high total solids in such waters is remarked on. These solids are generally largely Sodium Chloride and often Sodium Bicarbonate. Unless the figure for total solids approaches 100 parts per 100,000 it is said not to be excessive, the average for the thirteen samples being 78·09.

Organically it is favourably spoken of.

It is probable that the above was a mixture of deep well water and subsoil water.—J. C. T.

* See explanation on p. 348.

New supply. No. 1 Borehole.

By Dr. J. C. Thresh, 1904. From Dr. Reece's Report to the Local Government Board, No. 281, p. 10.

"This water is practically the same as the sample examined when the well was first bored."

"It is alkaline (containing carbonate of soda) and water of this character is common to both chalk and Thanet sands over a great area of this county."

"The sedimentary character is due to very fine sand."

Physical Examination.—Exceedingly turbid. Colour normal, when filtered. No odour.

	In parts per 100,000
Chlorine	48·6
Equivalent to chlorides 60 per cent.	80·8
Nitric nitrogen. Equivalent to nitrates 17 per cent. N.	·0
Nitrites	Minute trace.
Lead, copper, zinc, iron	·000
Free ammonia	·132
Organic ammonia	·004
Oxygen absorbed at 98° F. in 3 hours	·039
Hardness	11°

Wivenhoe.

Several analyses by Dr. J. C. Thresh.

A.—First boring for public supply. See pp. 317, 318. Abandoned. 12th July, 1900.
B.—Second boring for public supply. See p. 318. Sample of water first struck.
C.—Same. Sample after 4 days' pumping.
D.—Same. 29th January, 1901, at the end of the trial-pumping.
E.—Same. Taken 9th January, 1912.
F.—From 4-in. bore at Wivenhoe Hall. See p. 317. June, 1898.

In parts per 100,000

	A	B	C	D	E	F
Ca.	2·1	2·2	2·2	2·2	2·9	1·6
Mg.	1·65	1·65	1·7	1·85	1·7	1·2
Na.	59·6	—	—	40·3	40·5	43·
K.	·1	—	—	—	—	—
CO_3	18·	19·	19·	18·8	18·8	18·2
SO_4	10 8	10·55	10·	10·	9·6	13·
Cl.	70·9	41·9	41·9	41·9	43·	41·2
NO_3	·3	·4	—	—	·3	·4

Probably combined as :—	A	B	C	D	E	F
Calcium carbonate ...	5·25	5·5	5·5	5·5	7·2	4·
Magnesium carbonate ...	5·75	5·75	5·95	6·45	5·9	4·2
Sodium carbonate ...	19·05	20·5	20·25	19·2	18·2	22·6
Sodium sulphate ...	16·	15·6	14·6	14·8	14·2	19·25
Sodium chloride ...	117·	69·1	69·1	69·1	70·9	68·
Sodium nitrate	—	·55	—	—	·4	·55
Potassium nitrate ...	·4	trace	—	—	—	—
Silica, &c.	2·55	1·0	2·6	·45	·2	—
*Total solids dried at 180° C.	166·	118·	118·	115·5	117·	116·5
Hardness: Temporary ...	8·5	—	—	—	15°	—
Permanent ...	4·	—	—	—	0°	—
Total ...	12·5	13	14°	13°	15°	—
Free ammonia	·1	·057	·097	·102	·004	—
Organic ammonia	·004	·0056	·006	·003	·001	—
Oxygen absorbed in 3 hours at 37° C. ...	·036	—	—	·033	·032	—
Nitrites	0	—	—	0	0	—

* Total solids of F. by estimation 118·6, the sample being too small to verify.
E.—Clear and bright. Excellent appearance. No deposit. Very faint yellow. No odour.
F.—Clear and bright.

Woodham Ferrers and Woodham Walter.

By Dr. J. C. Thresh.

In parts per 100,000

	Woodham Ferrers, Hyots Farm on the Marshes, 26 Feb., 1898, see p. 319.	Woodham Walter, W. Walter House, near Hoe Mill, 27 March, 1903, see p. 319.
Calcium carbonate	4·25	3·75
Magnesium carbonate	3·15	1·95
Sodium carbonate	31·2	38·9
Sodium sulphate	12·1	16·3
Sodium chloride	58·6	49·8
Sodium nitrate	·3	No nitrates
Silica, &c.	·9	—
Error	—	—·7
Total solids dried at 180° C.	110·5	110·
Hardness: Temporary	7°	5·3°
Permanent	3°	·7°
Total ...	10°	6°
Free ammonia	·000	·1
Organic ammonia	·005	·004
Oxygen absorbed in 3 hours at 37° C. ...	·124	·088
Nitrites	—	nil.

Writtle.

A.—Well (now Chelmsford Rural District Council). On roadside, half-way up Oxney Green. See p. 319. July, 1898.

B.—Boring of 1902. Chelmsford Rural District Council. At the top of Oxney Green. See p. 320. 5th November, 1902.

C.—Same as *B.* 2nd June, 1911.

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	C	Probably combined as:—	A	B	C
Ca.	1·65	1·8	·79	Calcium carbonate	4 15	4·5	1·97
Mg.	·55	·6	·15	Magnesium carbonate	1·9	2·1	·52
Na.	33·66	35·3	36·76	Sodium carbonate ..	26·1	27·9	32·65
Fe.	trace	—	—	Sodium sulphate ...	21·	18·65	13·6
CO_3	18·7	20·	20·	Sodium chloride ...	39·1	43·55	45·85
SO_4	14·2	12·6	9·2	Sodium nitrate ...	·45	0	·42
Cl.	23·7	26·4	27·8	Silica, &c.	·8	·8	1·49
NO_3	·34	0	·31				
				Total solid constituents dried at 180° C. ...	93·5	97·5	96·5
				Hardness: Temporary	5°	5°	—
				Permanent ...	0°	1°	—
				Total ...	5°	6°	5°
				Free ammonia	·02	·06	·000
				Organic ammonia	·05	·004	·004
				Oxygen absorbed in 3 hours at 37° C. ...	—	·1	·045
				Nitrites	nil	nil	nil

B.—No turbidity.

Site Doubtful.

Mr. Deloitte's House. Near Grays. See p. 321.

Made by Dr. LETHEBY. Communicated by D. T. ANSTED, 1878.

	Grains per gallon ?
Ammonia, actual or saline	·003
,, organic	·005
Nitrogen as nitrates, &c.	·695
Carbonate of lime	8·34
*Carbonates of lime and magnesia	1·95
Sulphate of lime	1·37
Alkaline sulphates	18·09
Carbonate of soda	7·53
Chloride of sodium	14·14
Alkaline nitrates	4·12
Silica, alumina, and iron oxide	·69
Organic matter	·14
Total solids ...	56·27

Hardness, initial 14·8°; after boiling 11°

* Must mean Carbonate of Magnesia alone. See previous line.

Postscript to **Wivenhoe**, p. 464.

A. (July, 1900)—This water is one of those characteristic of certain parts of Essex, containing very little of the salts of lime and magnesia, but much carbonate sulphate and chloride of sodium. Unfortunately the amount of chloride of sodium is much higher than usual. There is no water-supply in the county with nearly so much salt; there are, however, two or three private wells which contain about the same quantity and are in use. There is no other objectionable constituent.

B., *C.*, *D.* (January, 1901)—As regards chlorine these are practically identical. The water contains no saline ingredient which, either in quality or quantity, can be injurious. There are other public supplies in the county containing about the same proportion of salt, and many private supplies which contain more. Organically the water is very pure, in fact it is doubtful whether it contains a trace of organic matter.

There can be no question of the infiltration of tidal water, as the Chalk is covered by about 100 ft. of London Clay and Reading Beds (chiefly clay); and that the salt present is not due to tidal water is proved by the absence of other magnesia-salts than the carbonate.

Compared with other deep Chalk-waters in the county the water is excellent, and compared with the majority of those got in the Tendring district the chlorides are low.

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It should be understood that for the purpose of this Memoir all the information concerning water-supply in the various Geological Survey Memoirs and in the papers on Essex Wells has been extracted, and that other works have been largely put under contribution. Nevertheless it is useful to have a systematic list.

GEOLOGICAL SURVEY PUBLICATIONS.

Maps.

Sheets of the original series. On the scale of an inch to a mile.

1, NW., all but W. margin (Brentwood, Chipping Ongar, Epping, Hoddesdon, Waltham Abbey). By W. Whitaker, W. B. Dawkins, W. H. Penning, H. B. Woodward and F. J. Bennett, 1868. Drift Edition, 1871.

1, NE. (Billericay, Chelmsford, Ingatestone, Maldon). By H. W. Bristow and W. B. Dawkins, 1868. Additions by H. B. Woodward, 1870. Drift by W. B. Dawkins, W. H. Penning and H. B. Woodward, 1871.

1, SW., about half (Barking, Romford, Stratford, etc., Valley of the Thames). By W. Whitaker and W. B. Dawkins, 1868. Drift Edition, 1872.

1, SE., over half (Langdon Hill, Rayleigh, Southend, Valley of the Thames). By H. W. Bristow. Drift partly by W. B. Dawkins and H. B. Woodward, 1868. Drift Edition, 1871.

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Sheets of the new series (London District). On the scale of an inch to a mile.

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Sheets of the Index Map. On the scale of 4 miles to an inch.

12 (original series). 1890.

16 (new series). N. part of County. 1907.

20 ,, S. ,, ,, 1907.

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1877. The Geology of the Eastern End of Essex (Walton Naze and Harwich). By W. Whitaker. Well Sections, pp. 21–25.

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1867. Buchanan [Sir G.]. Report . . . on the Results which have hitherto been gained . . . by Works . . . designed to promote the Public Health. 9 *Rep. Med. Off. Privy Council*, p. 40. (Chelmsford, pp. 155–158.)

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RANGER, WM. Report . . . on a Preliminary Inquiry into the . . Supply of Water . . . of Waltham Abbey. (Short note, p. 11.)

1852. RAMMELL, T. W. Report . . . on a Preliminary Inquiry into the . . . Supply of Water . . . of Halstead (pp. 20–24).

1855. DICKENS, ALF. L. Report . . . on a Preliminary Inquiry into the . . Supply of Water . . . of West Ham (p. 11).

ADDENDA.

There are some matters which escaped notice until this Memoir had been set up in pages, and so could not be put in their proper places. Besides which some well-sections and water-analyses came to hand too late for such insertion. These are now given, with references to the pages to which they belong.

Water from Gravel (p 7).

The following interesting remarks on water from gravel were made many years ago by the REV. J. CLUTTERBUCK, a well-known authority, in a Prize Essay on Water Supply.([1])

"Where the beds of gravel are deep and extensive, it is obvious that water may be led away from a hill-side and form a perennial stream of the greatest value."

"This is well illustrated on the well-known Tiptree Hall Farm. When first occupied by Mr. Alderman Mechi, land-springs issued from the slightly-rising ground to the north of the house, the weepings of which generated a peat-bed. Deep drains were driven into the hill-side, cutting through the margin of the gravel into the clay beneath, whence so large a quantity of water was gathered into one head as to supply all the ordinary wants of the homestead, and furnish a volume sufficient to carry out at all seasons the system of irrigation coextensive with the farm, whilst its overplus carries health and comfort to a once fever-stricken district in its course below. As the utilisation of this water is instructive, so in the source whence it flows a lesson may be learned as to the geological and physical conditions under which a like supply may be turned to good account elsewhere."

"The village of Tiptree stands on an extensive bed of drift-gravel and sand, resting on the tertiary clay, naturally drained by streamlets which flow down the shallow valleys or depressions by which it is flanked or intersected. As in all such cases, the subterranean water is upheld in the soil at an angle [a level] above its outfall, varying with, and dependent on the closeness of the sand or gravel in which it lies. The water in the village wells stood, in the autumn of 1864, 16 or 18 feet above the artificial and over-flowing vent given to it by Mr. Mechi's drains. It is on record that, when these drains were first dug, many, if not all, the wells in the village were more or less affected."

The springs in question, however, have been used only for the farm (Tiptree Hall), some way southward from the village, which has an independent supply, see p. 81.

[1] *Journ. R. Agric. Soc.*, 1865, vol. i., pt. ii.

Contamination—Local Cases (*p.* 58).

In a paper on "An Outbreak of Typhoid Fever attributed to a specifically polluted Spring Water,"(1) one of us dealt with an occurrence at Halstead in 1896.

Dr. G. Roberts, the Medical Officer of Health, "suspected that the spring supplying a drinking fountain on Mount Hill (where the cases of Typhoid Fever were occurring) had become contaminated and was disseminating the disease"; the water became turbid after a heavy rainfall, and therefore was suspected. A local chemist reported on a sample that "it was all that could be desired." Nevertheless Dr. Roberts plugged up the fountain.

After investigation "no other satisfactory explanation of the outbreak but the fountain water" could be found, and its source was examined. The pipes conveying the water from the alleged spring to the tank, in which it was held, were traced and found to be old-fashioned land-drains, which passed under the main sewer, where this was defective and in one place broken. This sewer took the sewage from the Isolation Hospital and from a few cottages. Probably "with the dry weather flow there was little or no escape of sewage, but during heavy rain there must have been a considerable escape."

The proof was completed by the fact that "one person only who was attacked resided at a distance from the spring and upon inquiry it was found that this man preferred the spring water to the water from the town mains and obtained all his drinking water from the spring."

An analysis (by the writer) of the turbid water collected after rain, on being compared with that of the local chemist, of a fine weather sample, showed some great differences (notably in the free ammonia and the oxygen absorbed), and bacteriologic examination showed that "there was no doubt about the pollution being due to fæcal matter, and as this came in part from the hospital in which there were three Typhoid patients there could be no doubt about the specific character of the pollution."

The cold weather and the prompt action of the Medical Officer probably prevented an extensive epidemic.

It may be of interest to note the former state of things in various places, as shown in official Reports, including the valuable ones made to the General Board of Health, the ancestor of the present Local Government Board. These Reports are probably to be seen but rarely, which is a reason for drawing attention to them. Of course, the things described in them have mostly passed away; but the evil state of things referred to still continues in some of the more out of the way country-places.

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[1]Dr. J. C. Thresh, *Journ. State Medicine*, 1897, vol. v., no. 4. pp. 178–180.

That early pioneer in sanitary matters, Sir E. CHADWICK, drew attention to various defects in Essex water-supply, quoting the reports of local medical officers [1] as follows:—

"*Mr. Henry Cribb*, the medical officer of the Dunmow union reports, as a circumstance which is highly injurious to the health,—'The want of good and wholesome spring-water: there being scarcely any pumps for the use of the poor, they are compelled to use water collected from ditches; and I have known it frequently to be not only very impure, but almost in a putrid state.'"

"The medical officer of the Bishop's Stortford union (which comprised many parishes in Essex), states . . . 'that, in this and most of the rural parishes, complaints often arise from the want of good and wholesome spring-water, there being very few pumps, or even wells, and the poor being compelled to use water collected from ditches and other impure sources.'"

"*Mr. Whilpels*, the medical officer of the Lexden and Winstree union, states:—'There is a point . . . most worthy of notice . . . the deficiency of spring-water. The inhabitants of Salcot Virley and Great Wigborough are compelled to drink pond-water, which is impure, brackish, and most injurious to the constitution. The few who have the means, send for water a distance of four miles; to obviate the evil would be a blessing conferred upon the great mass of the population.'"

In 1849 E. CRESY described the water-supply of Chelmsford, and noticed that deep borings had been made by many people, and he mentions eight in the town and six in Springfield, with depths varying from 240 to 295 ft. In some the water overflowed. It is a pity that no detailed records of these wells have been kept, and some of their sites could now hardly be found.

In the same year W. RANGER gave a short note on the water-supply of Waltham Abbey, as follows:—"The water sources at present used . . . are fourfold, *i.e.*, the corn-mill stream, artesian borings, common wells, and ponds." But no details are given.

In 1850 E. CRESY said of Braintree:—"The houses are generally supplied from pumps. The wells vary in depth, some exceeding 40 feet. The water is exceedingly hard, and in many places affected by the drainage, which being suffered to filter away, naturally occasions much organic matter to descend to the stratum, from whence the pumps draw their supply. In several instances old wells are actually converted into cesspools, which, by their proprietors, are considered an unusual advantage from their not requiring any cleansing."

He adds that "the land around the town abounds with springs," and advocates their use.

[1] Report . . . on an Inquiry into the Sanitary Condition of the Labouring Population of Great Britain, 8vo., *London*, 1842, pp. 65, 66.

In 1852 T. W. RAMMELL dilated at some length on Halstead. "The town is very badly off as regards water supply. There being no public provision for the purpose, the inhabitants chiefly depend upon wells, which are few, and in most cases yield an excessively hard water. Sometimes they go to the river, and several small rills." In 1846 a supply was attempted on Mount Hill, where a well was sunk to the depth of 116 ft., and the water stood 33 ft. down; but it was abandoned, apparently because the yield was not enough.

He notes four springs on the western side of the river:—(1) rising at Kiln Farm; (2) on the side of Mount Hill, falling into the river near the bridge; (3) on the Chapel-house estate, falling into the river just above the mill; (4) on Tyding's Hill, falling into the river above Parson's Bridge; and two on the eastern side; (5) Holywell, rising in Parson's Lane, down which it passes; (6) at the Wash, flowing into the river below Box Mill. These he thinks available for use, whilst others are too distant. "The water at all the above springs is bright and sparkling, and is considered to be good," but is very hard, as determined by DR. L. PLAYFAIR [LORD PLAYFAIR]; nine spring-waters varying from 8·2 (the next lowest 18·2) to 34·5 degrees of hardness.

Of West Ham A. L. DICKENS had little to say, as regards water, in 1855. "There are several courts and other places supplied by pumps; but in scarcely any instance is the water good."

And in 1857 he also said little of Brentwood. "The water supply is derived from wells and pumps. There are about 100 private pumps and two public pumps in the hamlet. . . Water is obtained at a depth of about 40 feet, but the wells at this depth are liable to fail in very dry seasons."

In 1914 DR. THRESH enquired into the water-supply of Great and Little Oakley. The following remarks are taken from his Report, published in 1915:—

The wells from which the supply was got varied from 6 to 30 feet in depth, were mostly uncovered and inefficiently protected. Most were "liable to serious contamination; obvious sources of pollution being visible around," of which examples were given. Several condemned wells were left open. "The whole water supply is extremely hard, varying from 30 to 85 degrees of hardness, and moreover is very impure; that of Great Oakley being particularly foul." The water of 12 of the 14 wells examined was greatly polluted; that of one was slightly polluted; that of "one only was passable as satisfactory." The mains of the Tendring Hundred Company extend into these parishes, so that a good supply is available.

A similar report was made on the well-water at Ingrave and Herongate, and analyses of most of those at Castle Hedingham showed that most of them were polluted.

Wells.

Abberton (see pp. 85, 86).

The Glebe.

Made and communicated by H. C. Smith.

A boring of 5 in. internal diameter.

Water-level, 122 ft. down.

		Thickness. Ft.	Depth. Ft.
[London Clay.]	Yellow clay	48	48
	London clay	144	192
	Stone	1	193
	Dark sandy clay	22	215
[Reading Beds, 75 ft.]	Mottled clay	20	235
	Coloured sands	18	253
	Dark green blowing sand ...	11	264
	Dark grey sand	21	285
	Brown sand	6	291
	Dark green sand	8	299
	Flints	1	300
[Upper.]	Chalk and flints	100	400

For an analysis of the water, see p. 485.

Abbess Roding.

Ordnance Map 240, new ser. (Essex 42.) Geologic Map 47.

The Rectory. 1913.

Made and communicated by H. G. Featherby.

About 235 ft. above Ordnance Datum.

Water-level about 110 ft. down (1915). Pumping has gone on only for about 12 hours altogether, at the rate of 350 gallons an hour, and the yield seems to be free.

			Thickness. Ft.	Depth. Ft.
[Glacial Drift.]		Boulder Clay, with many Chalk stones	90	90
[London Clay, 130ft.]		Brown and grey clay	105	195
		Clay, with sandy stone 18 in. at top, from 198 to 199 down, and 2 ft. at bottom	18	213
		Clay with fragments of shells ...	2	215
	[Basement-bed ?]	Black pebbles, with traces of red mottled clay	5	220
		Hard stone, a conglomerate of flint pebbles	8¼	228¼
[Reading Beds, 36¾ft.]		Tough red clay, with red and green mottled loam	16¾	245
		Grey and green sand with loamy veins	20	265
[Thanet Sand, 35 ft.]		Live running sand	5	270
		Darker sand, more loamy	30	300
[Upper.]		Chalk with flints	35	335

The thickness of the pebbles below the London Clay is suggestive of the presence of Blackheath Beds.

For an analysis of the water, see p. 486.

Barking (p. 91).

Messrs. White's.

Two borings, made and communicated by MESSRS. ISLER & Co.

No. 1 1899. To get water from the gravel.

31 ft. 3 in. of 6-in. tube, 1 ft. 3 in. above surface. Water-level, 17½ ft. down.

		Thickness. Ft.	Depth. Ft.
Made ground	... ...	5	5
[River Drift.]	Sand and gravel ...	7½	12½
	Ballast [gravel] ...	4½	17
	Yellow sand	8	25
	Ballast	7	32

No. 2, 1906. To get water from the Oldhaven sand

10-in. tubes, 3 ft. 2 in. below surface, for 50 ft.

8½-in. tubes, 2 ft. 6 in. below surface, for 85 ft.

Water-level, 37½ ft. down. Yield, 1,000 gallons an hour.

		Thickness. Ft.	In.	Depth. Ft.	In.
Made ground	... ...	6	0	6	0
[River Drift.]	Fine ballast [gravel]	9	0	15	0
	Sand	6	0	21	0
	Coarse ballast	7	6	28	6
[London.] Clay, with claystone from 78 to 79 ft. down		53	0	81	6
[? Oldhaven Beds.]	Sand and shells	0	6	82	0
	Sand and pebbles	9	10	91	10

Corringham (see pp. 132–134, 267).

1. Thames Haven. Asiatic Petroleum Co., By the sea-wall, N.N.E. of cattle-landing station. 1915.

Made and communicated by MESSRS. ISLER & Co.

80 ft. of 11½-in. tubes, 2½ ft. down; 280 ft. of 10-in. tubes, 2½ ft. above ground. Water-level, 28 or 29 ft. down.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Soil	1½	1½
	Loamy soil	2	3½
	Sand and clay ...	2	5½
	Running sand ...	20½	26
	Peat	1	27
	Running sand ...	19	46
	Black clay	3	49
	Light-blue clay ...	1½	50½
	Brown clay	½	51
[River Gravel.]	Ballast	19	70
[London Clay, and Oldhaven Beds. ?]	Dark blue clay ...	30	100
	Light-blue clay ...	14	114
	Sand and clay ...	8	122
	Sand and pebbles ...	5½	127½
[Woolwich Beds and Thanet Beds.]	Green sand	6½	134
	Sand and pebbles ...	8	142
	Grey sand and clay ...	7	149
	Green loamy sand ...	42	191
	Brown sand and clay	33	224
	Dark sandy clay ...	22	246
	Sand and pebbles ...	4	250
	Dark sandy clay ...	4	254
	Dark clay	20½	274½
[Upper.] Chalk and flints		275½	550

Corringham, cont.

2. Thames Haven. Motor Owners' Petroleum Combine, N. of Petroleum Wharf (Stanford), and $\frac{3}{4}$ mile N.N.W. of cattle landing station. 1915.

Made and communicated by MESSRS. ISLER & Co.

Dug 8 ft., the rest bored. 74 ft. of 10-in. tubes from 7 ft. down. 178 of $7\frac{1}{4}$ in. from 4 ft. down. Water-level, $22\frac{1}{2}$ to 25 ft. down.

		Thickness. Ft.	Depth. Ft.
Soil		2	2
[Alluvium.]	Mellow sandy clay	5	7
	Black clay	25	32
[River Drift, 48 ft. ?]	Running sand	19	51
	Ballast [gravel]	29	80
[Woolwich Beds and Thanet Beds.]	Grey sandy clay	4	84
	Green loamy sand	54	138
	Dark sandy clay	34	172
	Green sand and pebbles [?flints]	3	175
[Upper.] Chalk, and black flints		289	464

3. Thames Haven. Oil Processes, Limited. North-eastward of the above, and south of Reedham. 1915?.

Made and communicated by MESSRS. ISLER & Co.

94 ft. of $11\frac{1}{2}$-in. tubes from 6 ft. down; 180 ft. of 10-in. tubes from $5\frac{1}{2}$ ft. down.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Brown clay	5	5
	Sticky blue clay	29	34
[River Drift, ? 50 ft.]	Running sand	18	52
	Ballast [gravel]	32	84
[Woolwich Beds and Thanet Beds.]	Grey sand	4	88
	Grey loamy sand	52	140
	Dark sandy clay	42	182
	Green flints	$\frac{1}{2}$	$182\frac{1}{2}$
[Upper Chalk.]	Sticky chalk and flints	132	$314\frac{1}{2}$
	Chalk and flints	187	$501\frac{1}{2}$

The above three sections are of interest in regard to the depth to the Chalk in and near Thames Haven, especially when compared with the other two in Corringham (see pp. 132–134), and the two just outside that parish, in Stanford-le-Hope (see below).

These seven sections, all within a distance of a mile from east to west and within half a mile from north to south, show a difference of nearly 100 ft. (175 to $274\frac{1}{2}$) in the depth to the Chalk, the lowest figures being on the west and the highest on the east, whilst the middle one (public house) is not 25 ft. less than the highest.

The four western borings show depths to the Chalk of 175, 180, $182\frac{1}{2}$, and 201 ft., the shallowest being in the middle, and the deepest to the south.

The two easterly borings show a difference of only 6 ft. in the depth to the Chalk, the deeper being to the north.

We have therefore an easterly dip, with perhaps a suggestion of a fault on the west, where the beds rise more sharply.

In the seven borings, together with the shallower one at the Oil Wharves, the thickness of the Alluvium varies from 26 to 51 ft., and that of the River Drift from 19 to $58\frac{3}{4}$, the two together varying from 68 to $88\frac{1}{2}$, a considerable thickness for these deposits.

The presence of London Clay is indicated only in the three southern deep borings.

East Ham.

Beckton Works (see pp. 142–144). Gas Light and Coke Co.'s new well at the Tar and Ammonia Products Works. 1915.

Made by the Company and communicated by W. S. ADAM.

About Trinity High Water Mark = $12\frac{1}{2}$ ft. above Ordnance Datum.

Shaft throughout, lined 10 ft. into the Chalk. Diameter 10 ft. to 66 ft. down; 8 to 158 down; and $7\frac{1}{4}$ to 338 down.

Water-level, from the Chalk, about 63 ft. down.

Later, galleries were driven at 242 and 291 ft. down. A fault or fissure struck in one gave an increased yield.

		Thickness. Ft.	Depth. Ft.
Made ground	...	9	9
[Alluvium.]	Blue clay (silt)	6	15
	Peat	$2\frac{1}{2}$	$17\frac{1}{2}$
	Blue clay (silt)	4	$21\frac{1}{2}$
[River Gravel.]	Ballast	$23\frac{1}{2}$	45
[? Oldhaven Beds and Woolwich Beds.]	Shell-rock	1	46
	Blowing sand	1	47
	Sand and small shells (a few pebbles, of varying size)	2	49
	Sand	4	53
	Dark sand	2	55
	Shell and sand	$1\frac{3}{4}$	$56\frac{3}{4}$
	Clay and shell	$\frac{3}{4}$	$57\frac{1}{2}$
	Clay, sand and shell	8	$65\frac{1}{2}$
	Clay and small shell	$\frac{1}{2}$	66
	Blue clay and shell	6	72
	Green sand	5	77
	Dark sand	14	91
[Thanet Sand, $55\frac{3}{4}$ ft].	Sand	$52\frac{1}{2}$	$143\frac{1}{2}$
	Sand and pebbles [? flints]	$2\frac{1}{2}$	146
	Flints	$\frac{3}{4}$	$146\frac{3}{4}$
[Upper.] Chalk; with 66 layers of flints, rather irregularly distributed for the most part		$191\frac{1}{4}$	338

Felsted (p. 155).

Grammar School. Four wells and borings for the supply of the swimming-bath, at the end of the bath-house, 20 ft. apart.

Made and communicated by MESSRS. ISLER & Co., and notes from F. CHANCELLOR. The following section of one serves for all, as they were alike.

Dug well $8\frac{1}{2}$ ft., the rest bored, 4 in. internal diameter.

Water-level 25 ft. down.

[Glacial Drift.]	Chalky [Boulder] Clay	26	34 ft.
	Light-coloured rough sand and large stones	7	
London Clay	...	1	

Great Chesterford (see pp. 169, 170).

The Rectory.

Two borings made and communicated by C. P. MARTIN.

A.—In garden. Water-level, 20 ft. Stopped owing to the hole being too small to go on with.

		Thickness. Ft.	Depth. Ft.
Soil ...		2	2
[? Some River Gravel, the rest Glacial Drift.]	Gravel ...	11	13
	Yellow sand ...	20	33
	Yellow clay ...	3	36
	Blue sand ...	18	54
	Blue clay ...	14	68
	Blue clay and sand ...	22	90
	Blue clay ...	15	105
	Sand. Finished in running sand	3	108

B.—Water-level, 8 ft.

		Thickness. Ft.	Depth. Ft.
Soil ...		2	2
[? Some River Gravel, the rest Glacial Drift.]	Yellow sand ...	8	10
	Yellow sand and clay ...	8	18
	Yellow gravel and clay ...	6	24
	Blue clay ...	20	44
	Yellow clay and chalk ...	6	50
Chalk ...		98	148

For an analysis of the water, see p. 488.

Rainham (see pp. 245–248).

Spoil Rubbish Shoot Works. Messrs. Flower and Everett. By the Thames.

		Thickness. Ft.	Depth. Ft.
Light-coloured soil ...		$\frac{1}{2}$	$\frac{1}{2}$
[Alluvium.]	Brown clay ...	6	$6\frac{1}{2}$
	Light-brown clay ...	13	$19\frac{1}{2}$
[River Drift.]	Sand ...	$\frac{1}{2}$	20
	Ballast [gravel] ...	27	47
[Lower London Tertiaries.]	Dark sand ...	7	54
	Black pebbles ...	$\frac{1}{2}$	$54\frac{1}{2}$
	Sand and shells ...	$17\frac{1}{2}$	72
	Light-coloured sand	4	76
	Clay ...	2	78
	Green sand and clay	$61\frac{3}{4}$	$139\frac{3}{4}$
	Dark green sand ...	$10\frac{1}{4}$	150
	Flints ...	$\frac{3}{4}$	$150\frac{3}{4}$
Soft [Upper] Chalk and flints ...		60	$210\frac{3}{4}$

Stanford-le-Hope (see pp. 270–272).

London and Thames Haven Oil Wharves.

Three borings, made and communicated by MESSRS. ISLER & Co.

1. 40 ft. from river-wall. (?A mile W. of railway-station). 1907? 190 ft. of $8\frac{1}{2}$-in. tubes from the surface.

Water-level 15 ft. down at high water; 20 ft. at low water. Yield, 12,000 to 14,000 gallons an hour.

Stanford-le-Hope, cont.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Brown clay	5	5
	Dark clay	9	14
	Sand and clay ...	10	24
	Green sand	20	44
	Peat	1	45
	Green sand	4	49
[River Drift.]	Ballast [gravel] ...	42	91
[Woolwich Beds.]	Green sand	14	105
	Sand and pebbles ...	6½	111½
[Thanet Beds.]	Green sand	18½	130
	Sand and clay ...	32	162
	Dark clay	18	180
[Upper.] Chalk	and flints	328	508

For an analysis of the water, see p. 488.

2. ¼ mile eastward of 1. 1904?

70 ft. of 5-in. tubes, 1½ ft. above surface.

Water-level affected by the tide. 3 ft. down when tide is up.

		Thickness. Ft.	Depth. Ft.
Made ground	... ...	3	3
[Alluvium.]	Blue clay	14	17
	Sand and clay ...	12	29
	Green sand	11	40
	Dark clay	4	44
[River Drift, 24ft.]	Green sand	3	47
	Ballast [gravel] ...	9	56
	Light-coloured sand ...	2	58
	Ballast	10	68
[Woolwich Beds?]	Green sand and clay	18	86
	Sand and stone ...	3½	89½

This well has been filled up.

3. 1914.

210 ft. of 8½-in. tubes, from 6 in. down, and 200 ft. of 4 in. and of 1½ in., for air-lift.

Water-level, 28 ft. down.

		Thickness. Ft.	Depth. Ft.
Soil	... ...	2	2
[Alluvium.]	Yellow clay	4	6
	Dark clay	12	18
	Sand and clay ...	8	26
[River Drift, 54ft.?]	Grey sand	23	49
	Ballast [gravel] ...	31	80
[Woolwich Beds and Thanet Beds.]	Green sand	60	140
	Sand and clay ...	35	175
	Dark clay	26	201
[Upper Chalk.]	Chalk and flints ...	263	464
	Hard chalk	66	330

Waltham Abbey (see pp. 287–291).

Aimes Green Farm. About 1¾ miles north-eastward of the Abbey.
Made and communicated by MESSRS. ISLER & Co.
Lined with 120 ft. of 4-in. tubes from 85 ft. down.
Water-level 97 ft. down.

		Thickness. Ft.	Depth. Ft.
Dug well (? older. In London Clay) ...		—	95
Blue [London] Clay ...		50	145
[Reading Beds, 52 ft.]	Mottled clay with stones ...	10	155
	Dark green sand with pebbles ...	11	166
	Dead green sand ...	25	191
	Dead black sand ...	6	197
[Upper.] Chalk. Flints and Chalk ...		150	347

West Ham, Stratford (pp. 300–304).

Gas Light and Coke Co., Union Street. 1913.
Made and communicated by MESSRS. ISLER & Co.
132 ft. of 10-in. tubes, from the surface.
Water-level, 66 ft. down. Yield, 6,000 gallons an hour.

		Thickness. Ft.	Depth. Ft.
[Artificial.]	Concrete ...	1	1
	Made ground ...	1½	2½
[River Drift, 18½ ft.]	Dark brown clay ...	1½	4
	Green clay ...	1	5
	Brown clay ...	2	7
	Black ballast [gravel] ...	6½	13½
	Brown ballast ...	7	20½
[London Clay, 32 ft.]	Dark blue clay ...	18	38½
	Blue loam and stones ...	6½	45
	Blue clay ...	5	50
	Claystone ...	2½	52½
[Reading Beds, 35½ ft.]	Mottled clay ...	7½	60
	Light-green sand and pebbles ...	2½	62½
	Light-green sand ...	9½	72
	Sandy clay and pebbles ...	9	81
	Congealed ballast [conglomerate]	7	88
Dark green [Thanet] Sand ...		37	125
[Upper.] Chalk and flints ...		276	401

Trial-borings, not for water.

Barking (see p. 336).

Hollway Shoot, in the Marshes. Messrs. Cory's. Close to river-bank.
Three trials, made and communicated by MESSRS. ISLER & Co.
Sites measured from a copy of Essex Map, Sheet 74, S.W. (1898).
No 1, Middle. About 380 yards north-eastward of end of landing-stage, Ripple Marsh.

		Thickness. Ft.	Depth. Ft.
Made up ground ...		3	3
[Alluvium.]	Brown clay ...	4	7
	Loamy blue clay ...	6½	13½
[River Gravel], Thames ballast ...		35½	49
Thanet Sand (G. BARROW), Dark grey sand ...		7½	56½

Barking, cont.

No. 2, Western. About 50 yards E. of enclosure, Ripple Marsh.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Brown clay	½	½
	Mottled clay ...	4	4½
	Loamy blue clay ...	3½	8
	Peat	7	15
[River Drift.]	Grey sand	3	18
	Ballast [gravel] ...	2	20

No. 3, Eastern. About 760 yards east-north-eastward of end of landing-stage, Ripple Marsh.

		Thickness. Ft.	Depth. Ft.
[Alluvium.]	Mould	½	½
	Mottled clay	2	2½
	Peat	6	8½
[River Drift.]	Grey sand	3	11½
	Ballast [gravel] ...	2	13½

These, and the following, are of interest as showing the varying character and thickness of the Alluvium, and, in one case, a great thickness of River Gravel.

British Coalite Co., Creekmouth. About 20 yards farther from the river than the well noticed on p. 93.

Made and communicated by MESSRS. RICHARDS.

		Thickness Ft.	Depth. Ft.
Well (the rest bored)	? Alluvium ...	14	14
[River Drift ?]	Sand and gravel ...	3	17
	Gravel	2½	19½
	Sand	3½	23
	Gravel	14	37
	Sand	9	46

Analyses of Well Waters.

Abberton (see p. 354).

The Glebe, see p. 478.

By DR. J. C. THRESH, 30th April, 1914.

	In parts per 100,000.	
	Probably combined as:—	
Ca. 2·	Calcium carbonate ...	5·
Mg. 1·3	Magnesium carbonate ...	4·5
Na. 52·65	Sodium carbonate ...	29·
CO_3 22·6	Sodium sulphate ...	10·3
SO_4 7·	Sodium chloride... ...	93·2
Cl. 56·5	Sodium nitrate ...	·15
NO_3 ·1	Etc.	2.85

Total solid constituents dried at 180° C. ... 145·

Hardness: Temporary, 11°; Permanent, 2·5°; Total, 13·5°.

Free ammonia	·1215
Organic ammonia	·011
Oxygen absorbed in 3 hours at 37° C.	·18
Nitrites	nil

Little opalescence. Colour yellowish. Odour none. Reaction neutral.

Abbess Roding.

The Rectory (see p. 478)

By Dr. J. C. Thresh, December, 1913.

		In parts per 100,000.	
		Probably combined as:—	
Ca.	4·75	Calcium carbonate ...	11·73
Mg.	3·	Magnesium carbonate ...	10·38
Na.	9·82	Sodium carbonate ...	2·72
CO_3	15·9	Sodium sulphate ...	15·7
SO_4	10·6	Sodium chloride ...	8·9
Cl.	5·4	Sodium nitrate ...	·17
NO_3	·13	Trace of iron, etc. ...	1·4
		Total solid constituents dried at 180° C. ...	51·

Hardness: Temporary, 17°; Permanent, 10°; Total, 27°.

Free ammonia	·144
Organic ammonia	·0015
Oxygen absorbed in 3 hours at 37° C.	·036
Nitrites	·00

Slightly opalescent. Little fine sand present. Colour slight yellow. Odour none. Reaction neutral.

Barling.

Well of the Southend Water Co. (new).

By Dr. J. C. Thresh, June, 1915.

		In parts per 100,000.	
		Probably combined as:—	
Ca.	1·12	Calcium carbonate ...	2·8
Mg.	trace	Sodium carbonate ...	32·42
Na.	39·81	Sodium sulphate ..	14·06
CO_3	20·	Sodium chloride ...	51·1
SO_4	9·5	Silica, etc.	1·62
Cl.	31·		
NO_3	0·		
		Total solid constituents dried at 180° C. ...	102·

Hardness: Temporary, 2·8°; Permanent, 0.

Free ammonia	·032
Organic ammonia	·000
Oxygen absorbed in 3 hours at 37° C.	·03
Nitrites	nil

Trace of fine sand. Slight green tint. No odour. Reaction neutral. Note the practical absence of magnesium carbonate.

Boreham.

Bungalow. Well, 19 ft. deep.

By Dr. J. C. Thresh, June, 1915.

		In parts per 100,000.	
		Probably combined as:—	
Ca.	10·4	Calcium carbonate ...	26·
Mg.	·8	Magnesium carbonate ...	1·96
Na.	5·36	Magensium sulphate ...	1·18
CO_3	17·	Sodium sulphate ...	8·68
SO_4	6·8	Sodium chloride ...	4·6
Cl.	2·8	Sodium nitrate ...	2·74
NO_3	2·	Silica, etc.	1·84
		Total solid constituents dried at 180° C. ...	47·

Boreham, cont.

Hardness: Temporary, 23°; Permanent, 6°; Total, 29°.

Free ammonia	·002
Organic ammonia	·0032
Oxygen absorbed in 3 hours at 37° C.	·025
Nitrites	nil

Clear and bright. Faint green. No odour. Reaction neutral.

Dovercourt (see p. 383).

Deep Well at "The Tower."

By Dr. J. C. Thresh, October, 1912.

In parts per 100,000.

		Probably combined as:—	
Ca.	28·3	Calcium carbonate ...	23·
Mg.	12·	Calcium sulphate ...	64·9
Na.	11·3	Magnesium sulphate ...	59·3
CO_3	13·8	Sodium sulphate ...	4·3
SO_4	96·	Sodium chloride ...	24·7
Cl.	15·	Sodium nitrate	·7
NO_3	·5	Iron, silica, etc. (not determined)	27·1
		Total solid constituents dried at 180° C. ...	204·

Hardness: Total, 143°.

Free ammonia	·04
Organic ammonia	·008
Oxygen absorbed in 3 hours at 37° C.	·045
Nitrites	·000

Very dull. Slight deposit of iron-oxide. Colour yellow. Odour none. Reaction very faintly acid.

This water presumably comes from the base of the London Clay.

Earls Colne (see p. 388).

A.—Waterworks, see p. 142. First water reached, apparently from sand, 24th August, 1912.

B.—The same. 12 hours after starting pumping. 16th September, 1912.

C.—The same. After 12 days' pumping. 30th September, 1912.

D.—Atlas Ironworks (see p. 141).

By Dr. J. C. Thresh.

In parts per 100,000

	A	B	C	D	Probably combined as:—	A	B	C	D
Ca.	7·	8·7	8·	3·5	Calcium carbonate...	17·5	21·8	20·	8·75
Mg.	3·	1·8	1·57	2·75	Magnesium carbonate	10·4	4·9	5·37	9·65
Na.	4·2	4·55	6·9	17·9	Magnesium sulphate	—	2·	—	—
CO_3	20·	16·6	17·1	12·2	Sodium carbonate ...	3·7	—	2·3	—
SO_4	.7	2·2	2·7	7·7	Sodium sulphate ...	1·03	·6	4·	11·4
Cl.	3·6	6·6	6·9	21·5	Sodium chloride ...	5·9	10·9	11·4	35·5
NO_3	·13	·25	·26	·6	Sodium nitrate ..	·17	·3	·36	·8
					Silica, etc.	·3	1·5	·57	·9
					Total solid constituents dried at 180° C. ...	39·	42·	44·	67·
					Hardness: Temporary... ...	18°	—	20°	12°
					Permanent... ...	8°	—	6°	7°
					Total	26°	23°	26°	19°
					Free ammonia	·068	·028	·022	·056
					Organic ammonia	·004	·002	·002	0
					Oxygen absorbed in 3 hours at 37° C. ...	·081	·008	·018	·042
					Nitrites	nil	nil	nil	nil

Earls Colne, cont.

A.—Very thick and turbid, 2 in. deposit of dark grey clayey sand on resting. Colour, when settled, greyish. Slight odour of tar. Reaction neutral. Evidently contains some water from an extraneous, probably superficial, source.

B.—Deposit of Chalk. Faintly yellow. No odour. Reaction neutral.

C.—Clear. Very faintly yellow. No odour. Reaction neutral.

Great Chesterford (see p. 397).

Rectory. Well 148 ft. deep. Second boring, see p. 482.

By Dr. J. C. Thresh, May, 1915.

Bright. A few small particles of flocculent sediment. Very hard, but otherwise a very good water.

In parts per 100,000.

		Probably combined as:—	
Ca.	11·5	Calcium carbonate ...	28·7
Mg.	·6	Magnesium carbonate ...	·56
Na.	2·58	Magnesium sulphate ...	2·17
CO_3	18·7	Sodium sulphate ...	1·88
SO_4	3·	Sodium chloride ...	3·3
Cl.	2·	Sodium nitrate	2·47
NO_3	1·8	Silica, etc. Trace of iron	·92

Total solid constituents dried at 180° C. ... 40·

Hardness: Temporary, 25°; Permanent, 5°; Total, 30°.

Free ammonia	·004
Organic ammonia	·0032
Oxygen absorbed in 3 hours at 37° C.	·05
Nitrites, absent.	

Ramsden Bellhouse.

Ramsden Heath Pumping Station of the Southend Water Co. (see p. 244). From tap on rising main.

By Dr. J. C. Thresh. 1914.

In parts per 100,000.

		Probably combined as:—	
Ca.	·7	Calcium carbonate ...	1·7
Mg.	·3	Magnesium carbonate ...	1·05
Na.	36·6	Sodium carbonate ...	32·35
Fe.	trace	Sodium sulphate ...	18·95
CO_3	20·	Sodium chloride ...	40·9
SO_4	12·8	Silica, etc.	1·85
Cl.	24·8		
NO_3	·0		

Total solid constituents dried at 180° C. ... 96·8

Hardness: Temporary, 2·3°; Permanent, ·4°; Total, 2·7°.

Free ammonia	·05
Organic ammonia	·005
Oxygen absorbed in 3 hours at 37° C.	·07
Nitrites	nil

Slightly opalescent, clayey matter. Colour, faint yellow-green. Odour, none. Reaction, faint alkaline.

Stanford-le-Hope (see p. 440).

London and Thames Haven Oil Wharves, Ltd. Boring 508 ft. deep, see pp. 482, 483.

Communicated by N. A. ANFILOGOFF, Manager to the Company.

	In parts per 100,000.
Total solids	45·2
Organic carbon	·093
Organic nitrogen ...	·014
Ammonia	·07
Nitrogen as nitrates and nitrites	·024
Total combined nitrogen	·096
Chlorine	3·9

Total Hardness, 25°; Permanent, 3·8°.

Further Wells.

Barling.

Pumping station of the Southend Water Co., near the river, over a mile W.N.W. of All Saints' Church.

Communicated by E. C. BILHAM, 1915.

Surface of ground 18 ft., floor of engine-house 20 ft. above Ordnance Datum. Highest rest-level of water 146·5 ft. below Ordnance Datum.

Well 348¾ ft. down (330¾ ft. below O.D.). Six feet boring, unlined, 13¼ ft.; 4½ ft. boring 33½ ft.

		Thickness. Ft.	In.	Depth. Ft.	In.
Soil		3	0	3	0
[River] Gravel		9	6	12	6
London Clay ...		344	6	357	0
[? Oldhaven Beds, 11½ feet.]	Sand ...	2	4	359	4
	Sand pebbles and shells ...	2	8	362	0
	Hard black sand, with few pebbles	6	6	368	6
[Woolwich Beds.]	Light-coloured hard sand ...	13	0	381	6
	Muddy softer sand ...	14	0	395	6

Bocking.

1. Franciscan Convent, 1910?

Made and communicated by H. C. SMITH.

Water-level 46 ft. down. Yield, with the suction a foot in the water, 800 gallons an hour.

		Thickness. Ft.	Depth. Ft.
Well of 5 feet diameter (the rest bored)			50
[London Clay.]	London clay ...	54	104
	Stone or rock ...	2	106
[Lower London Tertiaries, 101 feet.]	Sandy clay and shells	29	135
	Mottled clay ...	10	145
	Coloured sands	18	163
	Brown sand ...	5	168
	Grey sand ...	33	201
	Chocolate-coloured clay	3	204
	Green sand ...	2	206
	Flints ...	1	207
[Upper] Chalk and flints ...		93	300

Bocking, cont.

2. Spencer's Cottages, Church Street, near the School.

Information got by MESSRS. COURTAULD AND Co. from the well-sinker, in 1885.

About 180 ft. above Ordnance Datum.

Supplies a number of cottages, and is said never to fail.

		Thickness. Ft.	Depth. Ft.
[Drift] Gravel	...	$17\frac{1}{2}$	$17\frac{1}{2}$
London Clay...	...	$155\frac{1}{2}$	173
[Reading Beds and Thanet Beds.]	Green clay ...	12	185
	Grey clay and sand ...	20	205
	Green sand ...	2	207
	Stone [flints] ...	$\frac{3}{4}$	$207\frac{3}{4}$
[Upper] Chalk	...	$80\frac{1}{4}$	288

Judging by the other wells here, and by those at Braintree, the so-called London Clay must include the greater part of the Reading Beds.

A sample of the water showed that surface-water was entering freely.—J. C. T.

Analyses of Deep Well Waters.

From Dr. Thresh's Report on the Water Supplies in the Chelmsford and Maldon Rural Sanitary Districts, 1891.

	In grains per gallon.					In parts per million.		
	Total Solids.	Nitric Nitrogen.	Chlorine.	Sodium Carbonate.	Total Hardness.	Free Ammonia.	Albuminoid Ammonia.	Oxygen Absorbed.
Cold Norton, corner of Fambridge Road... ...	97·	·05	26.	26·5	3·5°	·20	·03	·71
Dengie, Bridgwick Farm	114·	·05	47·	23·5	3°	·84	·04	1·35
Goldhanger, Rectory	120·	·03	46·4	24·5	6°	1·2	·02	·49
North Fambridge, Railway Station	93·	·16	28·	19·	7°	·00	·01	·6
,, Public Pump, near Ferry ...	91·	·125	26·4	21·5	5°	·01	·04	·71
Purleigh, Cold Norton Railway Station... ...	81·	·07	22·9	23·5	2°	·01	·015	·52
,, Public Pump	92·	·06	23·	26·5	3°	·00	·02	·60
Rettenden, Clarke's Well, junction of Rettenden and Runwell Roads	64·	·03	25·	22·1	2·4°	·60	·02	·60
,, Bell's Farm	—	·05	24·9	16·5	4·5°	·04	·02	·78
,, Railway Station, Battlebridge ...	80·	·05	23·6	19·	3°	·00	·01	·8
,, Pitts	76·	·16	23·	18·	5·5°	·44	·00	1·0
,, Malting...	75·	·08	23·	16·	6°	·40	·10	1·8
Runwell, Rectory	83·	·11	23·	24·	6°	·52	·01	·52
Woodham Ferrers, Pearle's Farm	76·	·06	22·2	25·5	3·5°	·25	·01	·7
,, ,, Railway Station	103·	·09	21·9	23·5	12°*	·02	·01	1·0

* The Water at Woodham Ferrers Railway Station contained some magnesium sulphate.

Although most of the above wells have been abandoned of late years, the analyses are important, as showing the character of the deep well-water in the district.

Analyses of Samples of Water from the Mains of the South Essex Water Co. at Grays.

By Dr. J. C. Thresh. In parts per 100,000.

This table shows the variations in the results of 58 Analyses, from 13th August, 1899, to 2nd April, 1900. Three earlier Analyses head the list and serve for purposes of comparison.

	Analytical Results.									Saline constituents, calculated.							
	Lime.	Magnesia.	Combined Carbonic Acid.	Sulphuric Acid.	Chlorine.	Nitric Acid.	Free Ammonia.	Organic Ammonia.	Oxygen Absorbed.	Calcium Carbonate.	Calcium Sulphate.	Calcium Chloride.	Magnesium Chloride.	Sodium Chloride.	Sodium and Potassium Nitrates.	Total saline constituents.	Total solids estimated by weighing.
Feb., 1873	—	—	—	—	5·05	3·6	—	—	—	—	—	—	—	—	—	—	44·8
Dec., 1897	17·9	2·1	9·85	5·7	18·7	2·6	·000	·000	·042	22·5	9·7	2·65	4·95	21·95	4·3	66·05	66·05
April, 1899	22·8	4·8	10·4	8·05	42·3	9·8	·006	·004	·018	23·8	3·7	7·8	11·45	47·4	16·15	120·3	124·
Aug., 1899	17·1	2·2	9·85	4·2	12·9	3·5	·000	·000	·006	22·5	7·2	·3	5·1	11·45	5·7	56·	57·2
to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to
April, 1900	22·4	5·8	12·2	10·6	38·6	7·1	·016	·008	·040	27·8	18·1	5·65	13·8	50·7	11·65	109·5	111·

Since these analyses were made the Company has not pumped to so excessive an amount as it did sometimes, and the result is that the chlorine now rarely exceeds eight parts per 100,000, and by the softening process the hardness is reduced to about 13°.

Analyses of Stanford-le-Hope Waters.

By Dr. J. C. Thresh. May 2nd–5th, 1899.

		Mr. Gentry's Well in Halfield Road.	Mr. Blyth's Well in Sandpits.	Mr. Burley's Well. (sunk 6 months ago.)	The so-called Parish pump in Rectory Road.	Mr. Dobson's Well in Victoria Road.	? Well Water from Mr. Porter's property, Southend Road.
	Appearance	Dull and yellow	Clear and colourless	Turbid and yellow	Clear and colourless	Turbid and yellow	Very turbid and dirty looking
Grains per gallon.	Chlorine	3·1	5·1	1·9	2·3	6·4	7·4
	Temporary Hardness	·5	3°	4°	·0	4°	·0
	Permanent ,, ...	12·5	13°	8°	8·5°	22°	24°
	Nitrites						
	Nitric Nitrogen	2·55	3·25	1·16	1·74	2·43	2·55
Parts per million.	Free Ammonia	·09	·07	·11	·08	·48	1·00
	Organic Ammonia	·08	·08	·10	·06	·40	·14
	Oxygen absorbed	·853	·853	1·23	·75	4·64	1·55

None of the waters are good as all give strong signs of the subsoil being polluted. The Nitrates (Nitric nitrogen) may be taken as the best indication of the degree of pollution. Mr Burley's Well and the so-called Public pump yield waters which are better than the others. Mr. Dobson's Well and Mr. Porter's yield water so polluted as to be unfit for drinking purposes. Mr. Gentry's and Mr. Blyth's cannot be considered safe waters.

INDEX.

Names of authors, informants and observers are in small capitals.

Names of places are in italics; those outside Essex being marked with an asterisk.

Other entries are in ordinary type.

PLATE 2.

Map showing the amount of Chlorine in Deep Well-waters.

Upon this plate are marked approximately the positions of various deep wells referred to in the Memoir, and the figures represent the amount of chlorine in the chlorides contained in the water therefrom in parts per 100,000.

It will be observed that whilst the chlorides are usually high near the coast, in some instances, as at St. Osyth and Brightlingsea, the deep wells yield water containing comparatively small quantities of chlorides, whilst inland, as at Layer Marney and Tiptree, the water is highly charged with these salts.

In certain cases considerable variation is found within a very limited area, as near Great Dunmow. In the town itself, and a little to the east, the Chalk yields water containing from four to five parts of chlorine per 100,000, whereas a little to the west, at Little Easton, the chlorine exceeds ten parts. The waters are different in character, that at Dunmow and to the east containing no sodium carbonate, whilst that to the west contains this salt.

These differences are marked along the line, referred to on page 21, separating the hard calcareous waters from the softer sodium carbonate (alkaline) waters.

In South Essex, over the whole of the Chalk-outcrop at Grays, the water contains but little chloride save near the bank of the Thames, where certain wells yield very saline water.

PLATE 3.

Map showing Wells yielding Alkaline Waters.

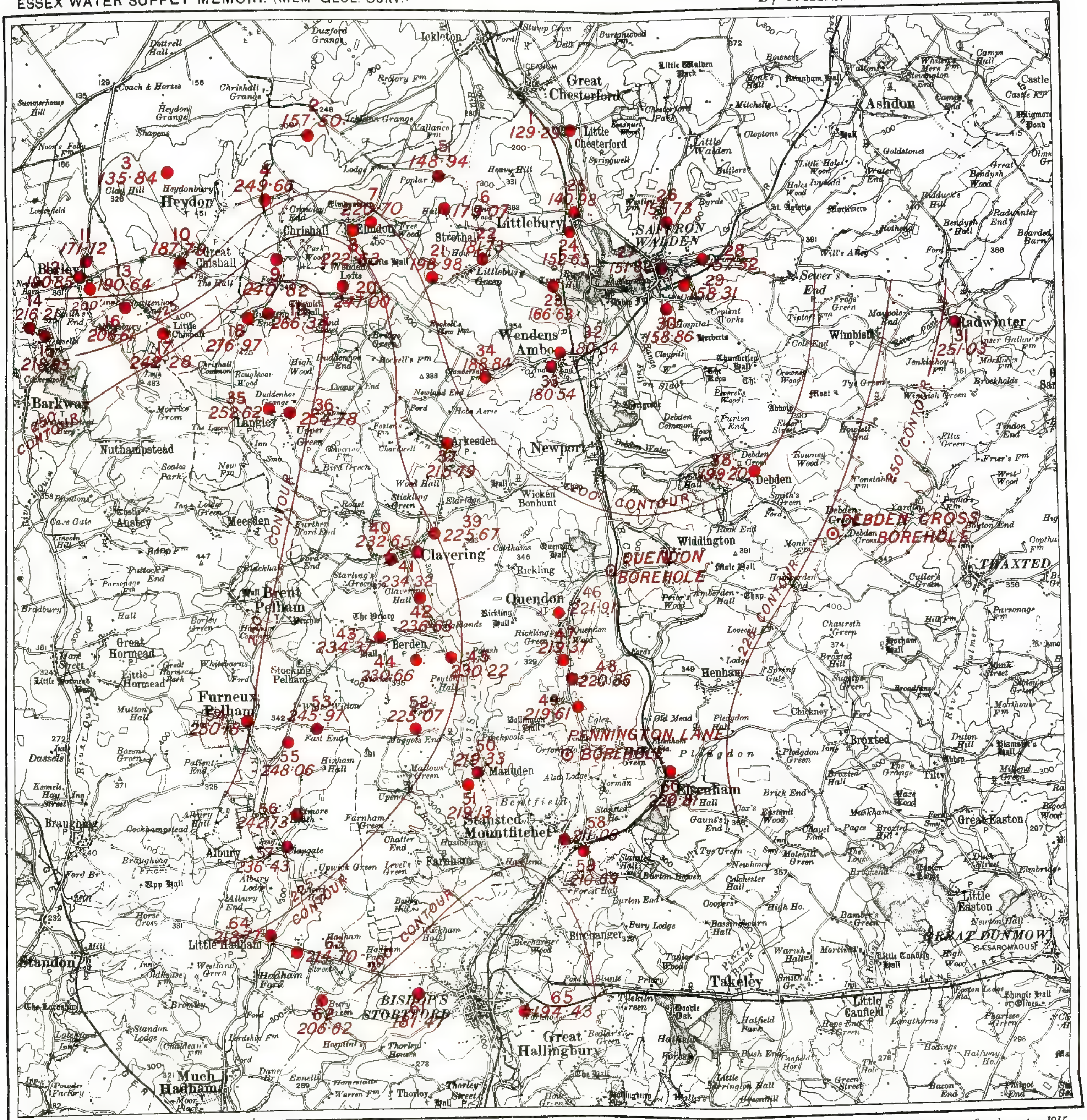
The solid dots represent wells yielding water containing sodium carbonate, and in most cases containing very little calcium carbonate. The rings represent calcareous waters containing some sodium carbonate, whilst the crosses refer to waters containing no sodium carbonate.

Over extensive areas the deep wells yield alkaline waters, the exceptions being wells (as at Althorne) yielding waters highly charged with magnesium sulphate. North of a line extending from Manningtree on the east to Bishop's Stortford on the west, practically all the deep wells yield a calcareous water. On the Grays Chalk-outcrop the water is also calcareous, and in the Lea Valley both varieties of water are met with.

A study of the two maps will afford safe indications as to the character of the water likely to be met with in deep borings in various parts of the county.

Map Showing the Underground Water Level in the Chalk Around the Head-Waters of the Stort and Cam.

ESSEX WATER SUPPLY MEMOIR. (MEM. GEOL. SURV.) By Messrs. H. Rofe & Son. PLATE 1.



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Scale of ½-Inch to One Mile = 1/126720

Ordnance Survey, Southampton, 1915.

Red spots show sites of wells, numbered 1-65. Red sloping figures show water-levels in feet. Red lines show underground water-contours.

RAINFALL MAP
OF
ESSEX.

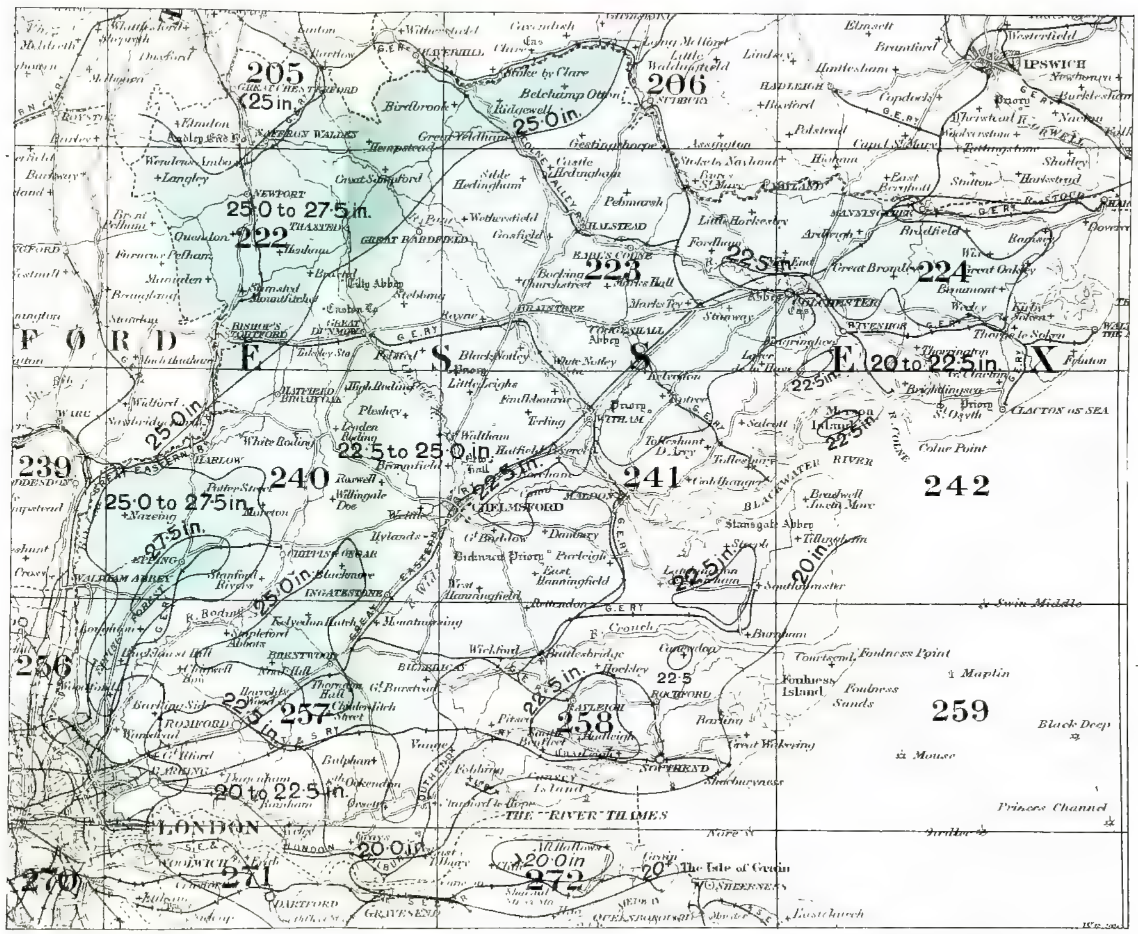
By H. R. MILL, D.Sc., LL.D.

REFERENCE.

Rainfall below 20 inches
,, between 20 & 22.5 inches
,, ,, 22.5 & 25 ,,
,, ,, 25 & 27.5 ,,
,, above 27·5 inches

Scale — 1 Inch = 10 Miles.
0 5 10

NOTE.—The larger numerals indicate the Nrs. of the New Series One-Inch Ordnance Survey Maps.



Printed at the Ordnance Survey Office, Southampton in 1915.